

DRAFT

BIOLOGICAL ASSESSMENT

OF THE

EFFECTS OF

PROPOSED ACTIONS

RELATED TO KLAMATH PROJECT OPERATION

APRIL 1, 2002 - MARCH 31, 2012

ON FEDERALLY-LISTED

THREATENED AND ENDANGERED SPECIES

Partially incorporating January 22, 2001 Biological Assessment
submitted to the National Marine Fisheries Service and
February 13, 2001 Biological Assessment
submitted to the U.S. Fish and Wildlife Service

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CHAPTER 1.0 - INTRODUCTION

1.1 INTRODUCTION

This biological assessment (BA) describes the Bureau of Reclamation's (Reclamation) proposed operation of the Klamath Project (Project). Reclamation is submitting this BA pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) to both the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to ensure that the proposed action is not likely to jeopardize the continued existence of listed species and to ensure that there is coordination between what may otherwise be conflicting needs between multiple listed species.

Under the relevant regulations, the "contents of a biological assessment are at the discretion of the Federal agency and will depend on the nature of the Federal action." 50 CFR § 402.12 (f). In the event that the Fish and Wildlife Service (FWS) or National Marine Fisheries Service (NMFS) determine that the proposed action is likely to jeopardize the continued existence of listed species, Reclamation has identified in Appendix A to this BA a list of actions that could be implemented as reasonable and prudent alternatives to the proposed action or as reasonable and prudent measures to reduce incidental take associated with the proposed action, or to promote conservation and recovery of listed species pursuant to Section 7(a)(1) of the ESA .

1.2 PURPOSE OF BIOLOGICAL ASSESSMENT

Reclamation's goal is to work with the Services toward developing an operations plan that meets Reclamation's legal commitments with respect to the Project in a manner that is consistent with the requirements of the ESA. Reclamation prepared this BA to describe and analyze the effects of its proposed actions related to operation of the Project on listed species. It covers proposed actions for 10 years, from April 1, 2002-March 31, 2012. This BA incorporates by reference and summarizes applicable and relevant portions of the BAs submitted to the FWS and NMFS in early 2001. Reclamation has also added new information to this BA, including:

- Proposed actions different from those described in previous BAs;
- A description of the environmental baseline condition that is consistent with ESA implementing regulations at 50 CFR § 402.02 and the FWS Section 7 Consultation Handbook;
- Additional analyses of the effects of the proposed action relative to the baseline such that the incremental effects on the listed species associated with proposed actions can be distinguished from the effects of non-Federal and non-Project actions.

1.3 SUMMARY OF 2001 CONSULTATION ACTIVITIES

On January 22, 2001 (Reclamation 2001a) and February 13, 2001 (Reclamation 2001b), Reclamation submitted BAs for proposed operation of the Project to NMFS and the FWS, respectively. NMFS and FWS issued final Biological Opinions (BOs) on April 6, 2001 (NMFS 2001) and April 5, 2001 (FWS 2001). Reclamation issued an Annual Operations Plan for the Project on April 6, 2001. The NMFS BO was effective through September 30, 2001, and the FWS BO was effective through March 31, 2002. Reclamation notified NMFS and FWS on August 17, 2001 that further consultation would be needed before April 1, 2002 for continuing operation of the Project. NMFS issued an amendment to its BO on September 28, 2001. On December 17, 2001, Reclamation requested an additional amendment to the NMFS BO. On December 28, 2001, NMFS issued an additional amendment that is effective through February 2002.

In an August 17, 2001 memorandum, Reclamation informed FWS of a number of concerns that need to be addressed in future Klamath Project ESA consultations, including:

1. Independent Science Peer Review. In June 16, 2001 testimony to the House Resources Committee, the Secretary of the Interior's Deputy Chief of Staff committed to an independent peer review of the science concerning the suckers and the coho salmon. On October 2, 2001, the Department of the Interior announced that it signed an agreement with the National Academy of Sciences (NAS) to review scientific and technical information regarding aquatic endangered species conservation in the Klamath Basin. The purpose of the NAS review will be to examine the underlying scientific information used by the Interior Department's Bureau of Reclamation and Fish and Wildlife Service and the Commerce Department's National Marine Fisheries Service to evaluate the effects of operations of the Project on aquatic species listed under the Endangered Species Act, particularly coho salmon and Lost River and short-nosed suckers. The NAS will consider hydrologic and other environmental parameters (including water quality and habitat availability) necessary for the listed species at critical times during their life cycles. The review will also evaluate probable consequences to these species when environmental parameters fall below these conditions. The NAS review will examine the scientific underpinnings of aquatic conditions necessary to recover and sustain these listed species. The NAS will evaluate existing scientific information and review the way it was applied in developing the February 2001 BAs of the Bureau of Reclamation and April 2001 biological opinions of the US Fish and Wildlife Service and the National Marine Fisheries Service. The National Academy of Sciences will provide an interim report by January 31, 2002, and a final report by March 30, 2003. The review is being jointly funded by the Departments of the Interior and Commerce.

2. Involvement of Contracting Districts, Tribes, and Other Parties. Contracting districts, Tribes, and other parties need to be involved in consultations and in developing long-term strategies for Project operation, given the basin-wide issues that need to be addressed. This is consistent with the Secretary of the Interior's "four Cs" policy, which commits all Interior agencies to communication, consultation, cooperation, and conservation when undertaking Departmental efforts.

3. Addressing the Impacts of Non-Project Actions. Reclamation believes that the Project should not be held responsible for effects of all of the water development and land management activities throughout the Basin, both Federal and non-Federal, on endangered suckers and threatened coho salmon. For example, the diversion and use of water by federal and non-federal parties upstream from Upper Klamath Lake under water rights that are junior in priority to those claimed by the United States for the Project may significantly deplete inflows to the lake, adversely affecting lake levels in, and flows downstream from, the lake. In particular, the Project should not be held responsible for impacts associated with upstream water uses permitted by the State of Oregon based on appropriation dates subsequent to those for the Project.

Likewise, the Project is not responsible for depletions that may result from the operation of FWS's upstream national wildlife refuge. Those impacts should be addressed in an intra-service consultation by FWS with respect to species listed by it, and in a consultation between NMFS and FWS with respect to species listed by NMFS.

4. Concerns Regarding a Potential RPA for Long -Term Project Operations. Project operations during the 2001 irrigation season were based on assumptions that were valid only for the 2001 operations year. Accordingly, Reclamation incorporated the 2001 BOs' RPAs for that year only. Potential reasonable and prudent alternatives for future Project operations must provide for the long-term operation of the Project in a way that can be applied in all types of water years.

5. Reasonable and Prudent Measures (RPMs). In separate discussions, Reclamation also notified the FWS last year with concerns over the scope of the reasonable and prudent measures FWS recommended to minimize incidental take of bald eagles. While Reclamation was able to obtain water through cooperative means from water users in the Basin to provide the protections sought by FWS, this remains another area where Reclamation and the Services need to ensure that any RPMs are consistent with applicable regulations.

CHAPTER 2.0 - DESCRIPTION OF THE ACTION

2.1 INTRODUCTION

Reclamation proposes, through consultation and development of a subsequent operations plan, to operate the Project to divert, store, and deliver Project water consistent with applicable law. For purposes of this BA, the proposed operations begin April 1, 2002 and continue through April 1, 2012. After completion of consultation with both the FWS and NMFS, Reclamation will develop an operations plan that provides for the continued operation of the Project while meeting its legal obligations under the Endangered Species Act; namely, to: (1) avoid any discretionary action that is likely to jeopardize the continued existence of listed species; (2) take listed species only as permitted by the relevant Service; (3) and use Reclamation's authorities to conserve listed species. For the purposes of this BA, impacts to listed species are assessed with respect to the separate actions of diversion, storage, and release or delivery of water.

Reclamation recognizes that it has the responsibility to operate the Project to not interfere with the exercise of valid senior Tribal water rights. However, because the operation described in this BA concerns only that which is necessary to meet the requirements of the ESA. Tribal trust obligations are beyond the scope of this BA.

2.2 SUMMARY OF LEGAL AND STATUTORY AUTHORITIES, WATER RIGHTS AND CONTRACTUAL OBLIGATIONS RELEVANT TO THE ACTION

2.2.1 Introduction

Legal and statutory authorities and obligations, water rights, and contractual obligations guide Reclamation's proposed action. The underlying authorities, responsibilities, and obligations related to Project operation were previously described in the 2001 BAs (Reclamation 2001a, 2001b). This section of the BA elaborates on those authorities, responsibilities, and obligations.

2.2.2 Legal and Statutory Authorities

The Klamath Project is one of the earliest Federal Reclamation projects. The Act of February 9, 1905, 33 Stat. 714, authorized the Secretary of the Interior (Secretary) to change the level of the several lakes and to dispose of certain lands that were later included in the Project. The Oregon and California legislatures, on January 20 and February 3, 1905 respectively, passed legislation ceding certain lands to the United States for use as Project lands. The Oregon statute expressly authorized the use of Upper Klamath Lake in any irrigation and reclamation undertaking by the United States. The Project was authorized by the Secretary on or about May 15, 1905, in accordance with the Reclamation Act of 1902 (43 U.S.C. § 372 *et seq.*, Act of June 17, 1902, 32 Stat. 388) and approved by the President on January 5, 1911, in accordance with the Act of June 25, 1910, 36 Stat. 835.¹ This authorization includes Project works to drain and reclaim lakebed lands of the Lower Klamath and Tule Lakes, to store waters of the Klamath and Lost Rivers, including storage of water in Lower Klamath and Tule Lakes, to divert irrigation supplies, and to control flooding of reclaimed lands. Under provisions of the Reclamation Act and contractual obligations, Project costs were to be repaid by the beneficiaries on the reclaimed project lands. These costs have been substantially repaid.

¹The Act of February 9, 1905 was based on the Reclamation Act of 1902, 32 Stat. 388, which provided for the construction and maintenance of irrigation works for the storage, diversion, and development of waters for reclamation of arid and semiarid lands. Section 1. The acts by the Oregon and California legislatures stated as their purpose to aid in the operations of irrigation and reclamation and for the storage of water in connection with the irrigation and reclamation operations.

2.2.3 Water Rights

2.2.3.1 General

Federal law provides that Reclamation obtain water rights for its projects and administer its projects pursuant to state law relating to the control, appropriation, use or distribution of water used in irrigation, unless the state laws are inconsistent with express or clearly implied congressional directives. 43 U.S.C. § 383; California v. United States, 438 U.S. 645, 678 (1978); appeal on remand, 694 F.2d 117 (1982). Water can only be stored and delivered by the Project for authorized purposes for which Reclamation has asserted or obtained a water right in accordance with Section 8 of the Reclamation Act of 1902 and applicable federal law. Reclamation must operate the Project in a manner that does not impair senior or prior water rights. Reclamation has an obligation to deliver water to the Project water users in accordance with the Project water rights and contracts between Reclamation and the water users (which may be through a water district). Water lawfully stored in the Project's reservoirs can be used for Project purposes to the extent the water is applied to beneficial use within the Project. Reclamation does not have authority to divert or store water for Project purposes when to do so would interfere with the exercise of senior water rights.

The beneficial interest in the Project water right is in the water users who put the water to beneficial use. Nevada v. United States, 463 U.S. 110 (1983). In Oregon, as in most western states, a water right is obtained through appropriation followed by application within a reasonable time to beneficial use. See ORS 539.010. Likewise, Oregon law (as well as California law) is similar to the laws of most other western states in that actual application of the water to the land is required to perfect a water right for agricultural use.² Federal law concerning Reclamation projects, which is consistent with Oregon law, also provides that the use of water acquired under the Act "shall be appurtenant to the land irrigated, and beneficial use shall be the basis, measure, and the limit of the right." 43 U.S.C. § 372. Beneficial use is determined in accordance with state law to the extent it is not inconsistent with Congressional directives. See Alpine Land & Reservoir Co., 697 F.2d at 853-854; see also California v. United States, 438 U.S. at 678. Reclamation does not have the discretion to unilaterally modify or reallocate the use of Project water, see, Nevada v U.S. 463 U.S. 110 (1983)(water rights decreed for irrigation purposes cannot be reallocated to fish and wildlife purposes by Reclamation). These authorities and the contracts with the United States create and define the extent of the water users' rights.

2.2.3.2 Appropriation by the United States

The United States filed its notice of intent to appropriate waters for the Project with the State of Oregon on May 19, 1905, "to completely utilize all the waters of the Klamath and Lost River Basins in Oregon." It is recorded in "Water Filings" on page 1. This notice was also published in the *Klamath Falls Express* of Klamath Falls, Oregon on June 15, 22, 29, and July 6, 1905. Similar filings were also made in California.³ The May 19, 1905, notice provided that the water was to be used "in the operation of works for the utilization of water in the State of Oregon under the provisions of the act of Congress approved June 17, 1902 (32 Stat. 388) known as the Reclamation Act." This appropriation of water for Project purposes was made as directed by Section 8 of the Reclamation Act of 1902 and in conformance with state law as it existed in 1905. 43 U.S.C. § 383.

² See ORS §§ 539.010 et seq.; State ex rel. v. Hibbard, 570 P.2d 1190, 1194 (Or. Ct. App. 1977); Alexander v. Central Oregon Irrigation District, 528 P.2d 582 (Or. Ct. App. 1974), and Cal. Water Code § 1240; Joerger v. Pacific Gas & Elec. Co., 276 P. 1017 (Cal 1929); Madera Irr. Dist. v. All Persons, 306 P.2d 886 (Cal. 1957).

³ Oregon statutes concerning the appropriation of water before February 24, 1909, the effective date of the Oregon Water Rights Act of 1909, provided that the extent of the appropriation was determined by the actual capacity of the completed diversion structure, assuming that the requirement to post a notice of intent to appropriate together with application of water to beneficial use within a reasonable time had occurred. See In re Waters of the Tualatin River and its Tributaries, 366 P.2d 174 (Or. 1961). The laws for appropriation of water in California that were in effect in 1905 were similar to those in Oregon. Cal. Civil Code of 1872, §§ 1410-22 (Deering 1977). The effective date of the California Water Commission Act, which established California's current appropriation scheme, is December 19, 1914.

Before the United States' filing on the water rights for the Project, the Oregon legislature passed a statute that stated in part as follows:

Whenever the proper officers of the United States, authorized by law to construct works for the utilization of water within this state, shall file in the office of the state engineer a written notice that the United States intends to utilize certain specified waters, the waters described in such notice and unappropriated at the date of the filing thereof shall not be subject to further appropriation under the laws of this state, but shall be deemed to have been appropriated by the United States.

Act of February 22, 1905, Ch. 5, title 43, L. O. L., section 2 (section 6588, L. O. L.). The Oregon Supreme Court held that when the United States complied with the procedure as established by the legislature of the State of Oregon in the above act the United States thereby obtained "title to all the then unappropriated water" of the river with priority dating from the date the notice was filed.⁴ See *In Re Umatilla River*, 168 Pac. 922 (OR. 1917) (concerning rights to the waters of the Umatilla River). The Reclamation Service of the United States filed detailed plans and specifications covering the construction of the Klamath Project with the State Engineer of Oregon on May 6, 1908, and on May 8, 1909, filed with the State Engineer proof of authorization of the construction of the works therein set forth. The United States met the requirements of this statute when it filed for the water rights of the Project in 1905. The U.S. has also claimed water rights for the refuges and for the Klamath Tribes, as well as for other federal agencies within the Basin.

2.2.3.3 Acquired Water Rights

In addition to initiating the appropriative rights procedure in the States of Oregon and California, the United States acquired certain rights from entities and landowners who had initiated the appropriation of water in the Project area before 1905. The fact that a considerable number of these rights were purchased by the United States indicates that early private development of the basin was already well under way at the advent of Reclamation. It was necessary to acquire these rights from the entities involved to facilitate Project operation. Reclamation has filed claims in the pending adjudication for water rights with a priority date of 1905 (and some earlier) for Project storage and use, including domestic and irrigation as well as incidental fish and wildlife, recreation, and flood control purposes.

2.2.3.4 Adjudication Proceedings

A formal adjudication of a river system establishes in a competent court the relative rights to the use of water within the area that is being adjudicated. Testimony is received from all persons claiming a right and the State makes determinations based on the testimony of the relative priority dates. The Klamath River Basin is in such a process.

The State of Oregon is in the process of adjudicating all of the pre-1909 water rights in the Klamath Basin. This includes water rights for the Project, Klamath Tribes (held in trust by the United States), and four Klamath Basin national wildlife refuges, among other federal and private rights. Various irrigation districts and individuals that receive water from the Project also filed claims in the adjudication for the Project water rights. These claims are similar, but not identical, to the claims filed by the United States for the Project water rights. There is currently no process underway for the adjudication or quantification of downstream (California) water rights.

Concurrent with the Klamath adjudication, the State of Oregon initiated an Alternative Dispute Resolution (ADR) process in an attempt to resolve as many water rights issues in the adjudication as possible to avoid litigation by

⁴ In addition, the Klamath River Basin Compact (Compact) provides the following concerning rights of the Klamath Project and rights of the United States in general.

There are hereby recognized vested rights to the use of waters originating in the Upper Klamath River Basin validly established and subsisting as of the effective date of this Compact under the laws of the State in which the use or diversion is made, including rights to the use of waters for domestic and irrigation uses within the Klamath Project.

Congress consented to the negotiation of the Klamath River Basin Compact (between the States of Oregon and California) by the Act of August 9, 1955, 69 Stat. 613 and to the Compact itself by the Act of August 30, 1957, Public Law 85-222, 71 Stat. 497.

various claimants. The U.S. and other water users and parties with interests in the Basin participated in the ADR process.

The State of Oregon began the adjudication of the Lost River system in the early 1900s. Certificates were issued to individuals who had rights predating the Project's filings. Since Reclamation was not a party to the adjudication, certificates were not issued to Reclamation or its contractors. The State did, however, set aside 60,000 acres for Reclamation to later claim certificates on.

A number of water users above Gerber Dam claimed to have not been notified of the adjudication. As a result, the State reopened the adjudication process and completed it in 1989. This portion of the adjudication set forth the relative priorities of water use above Gerber Dam. The Klamath County District Court affirmed last year that the United States was never a party to the Lost River Adjudication. Thus, the water rights of the United States, including those of the Project, remain undetermined. Currently, no proceeding is scheduled to complete this adjudication.

2.2.4 Perpetual Contracts

Project water, which is water stored or diverted for Project purposes, is delivered to project beneficiaries pursuant to various contracts with Reclamation. Reclamation entered into numerous perpetual contracts pursuant to the Reclamation Act of 1902 with various irrigation districts and individuals to provide for the repayment of project costs in return for the delivery of Project water to specified lands. In most cases, the contracts do not specify a particular amount of water, but rather create a perpetual obligation of Reclamation to deliver available Project water for beneficial use on the specified lands.

In all, over 250 perpetual contracts are administered either directly or through irrigation districts on the Project. The United States also entered into contracts with Project irrigation districts for the operation and maintenance of certain Project facilities. Irrigation Districts that fall into this category are Klamath Irrigation District, Tulelake Irrigation District, and the Langell Valley Irrigation District.

In addition to the above, Reclamation entered into numerous perpetual contracts that were written pursuant to the Warren Act of 1911. These contracts provide that Project water will be delivered at a certain point, and from there it is the responsibility of the contractor to construct, operate and maintain all the necessary conveyance facilities (i.e., pumps, laterals, and turnouts) to distribute that water to the lands identified in the contract.

2.2.5 Lease Lands

There are approximately 22,000 acres of agricultural lands within either the Lower Klamath or Tule Lake National Wildlife Refuges leased on an annual basis. As such, the U.S. Fish and Wildlife Service administers these lands; however, the irrigation water supplied to these lands is provided by Reclamation through contracts it has with Project irrigation districts. Leasing of these lands dates back to the 1930s.

2.2.6 Temporary Water Contracts

Each year, Reclamation determines whether surplus water is available to certain Project lands that are not covered by perpetual contracts. In many cases, these lands have been receiving surplus irrigation water from the Project for over 50 years. For numerous reasons, these lands were never given a perpetual contract. Concurrently, the Project irrigation districts also make a determination whether or not to sell surplus water. The irrigable acreage covered by surplus water contracts in 2000 was approximately 5,248 acres. Reclamation has discretion regarding the delivery of Project water to these lands.

The irrigable acreage represented by these temporary contracts is less than two percent of the total acreage irrigated on the Project. Water is delivered to these lands through the existing irrigation systems. In many cases, the water is delivered and controlled by the irrigation districts.

2.2.7 Power Contracts

In 1917, the United States entered into a contract with the predecessor to PacifiCorp, under which the power company constructed and conveyed to the United States Link River Dam at the outlet of Upper Klamath Lake. The power company also obtained the right to regulate the level of the Lake for power purposes subject to the needs of the Project for irrigation and reclamation requirements. The contract was renewed in 1956, as a result of FERC Project 2082 concerning the construction and operation of downstream Klamath dams operated by the power company. The present contract, which will expire in 2006, allows PacifiCorp to operate the dam within certain guidelines.

2.2.8 Endangered Species Act (ESA)

Each federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat unless that activity is exempt pursuant to the ESA. 16 U.S.C § 1536(a)(2); 50 CFR § 402.03. It is under this authority that Reclamation has prepared this BA.

Under section 7(a)(2), a discretionary agency action jeopardizes the continued existence of a species if it "reasonably would be expected, directly or indirectly, to reduce appreciably the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species." 50 CFR 402.02. If a discretionary agency action is jeopardizing a species, the agency must stop the action or adapt it through reasonable and prudent alternatives (RPAs), which must be within the scope of the agency's legal authority. 50 CFR 402.02.

Section 7(a)(1) requires federal agencies to exercise their authorities to conserve species. It does not, however, expand the powers conferred on an agency by its enabling act, but directs agencies to use their existing authorities to conserve endangered species. Platte River Whooping Crane Trust v. Federal Energy Regulatory Comm'n, 962 F.2d 27, 34 (D.C. Cir. 1992). In Sierra Club v. Babbitt, 65 F.3d 1502 (9th Cir. 1995), the Sierra Club contended that the section 7(a)(1) "duty to conserve listed species" provided the Bureau of Land Management (BLM) with additional authority for inferring Congressional intent to void preexisting agreements. Relying on Platte River, the court rejected this argument, finding that the Sierra Club "fail[ed] to point to any statutory provision that would allow the BLM to breach its existing agreements." Id. at 1510. The Fifth Circuit has also held that "the duty to consult and duty to conserve is tempered by the actual authorities of each agency" and concluded that "[w]hether a particular agency has the authority and/or ability to adopt programs for the benefit of a particular species . . . is a question on the merits." Sierra Club v. Glickman, 156 F.3d 606, 616 at n.5 (5th Cir. 1998).

Section 7(a)(1) alone does not, therefore, give Reclamation authority to undertake any particular action, regardless of its potential benefit for endangered species. Whether undertaken as section 7(a)(1) conservation activities or as RPAs subsequent to 7(a)(2) compliance, any Reclamation action for endangered species purposes must be within the agency's existing authority. Where there is no 7(a)(2) question (i.e., no indication that a proposed discretionary action is likely to jeopardize species), Reclamation's failure to take an action that is conceivably within its authorities cannot be determined to be a cause of "jeopardy."

2.2.9 Tribal Water Rights and Trust Resources

There are four federally recognized Indian Tribes in the Klamath Basin for which the Project operation is an important issue. These Tribes are the Klamath Tribes in Oregon, and the Yurok, Hoopa and Karuk tribes in California. The Klamath Tribes' water rights are currently included in the pending Klamath Basin adjudication in Oregon. There is currently no proceeding pending to determine the other tribes' water rights.

Although the Klamath Tribes' water rights have not yet been quantified in the pending Oregon adjudication¹, the existence of a federal reserved water right to support the Tribes' hunting, fishing and gathering rights under their 1864 Treaty with a priority date of time immemorial has been established by a federal court. This means that the

¹ As the Klamath Basin adjudication is still pending, no water rights have been quantified for those parties who filed claims. These parties include not only the Klamath Tribes (claims were also filed by the United States on behalf of the Tribes because those rights are held in trust for the Tribes by the United States), but also the United States for the Klamath Project and National Wildlife refuges, among others and the Klamath Project water users who also filed claims for Klamath Project water rights.

Project may not interfere with the exercise of these rights. This is dictated by the doctrine of prior appropriation as well as Reclamation's trust responsibility to protect tribal trust resources.

Reclamation anticipates that it will operate the Project consistent with the ESA to bypass impaired flows as needed to avoid jeopardy to the coho salmon. As stated above, Reclamation will address any additional tribal trust obligation in its operation plan to be released after completion of this consultation.

In addition, and consistent with its legal obligations, Reclamation also proposes to exercise its authorities to provide additional benefits to the Lost River and shortnose suckers and the coho salmon beyond those required by Section 7(a)(2) of the ESA.

2.2.10 National Wildlife Refuges

The Upper Klamath, Lower Klamath, Tule Lake, and Clear Lake National Wildlife Refuges are adjacent to or within the Project. These refuges were established by Executive Orders dating as early as 1908. The U.S. Fish and Wildlife Service under the Migratory Bird Treaty Act, the Refuges Administration Act, the National Wildlife Refuge System Improvement Act, and other laws pertaining to the National Wildlife Refuge System manage the refuges. These refuges support many fish and wildlife species and provide suitable habitat and resources for migratory birds of the Pacific Flyway. Portions of the refuges are also used for agricultural purposes. See the discussion above regarding leaselands. The refuges either receive water from or are associated with Project facilities.

The refuges have federally reserved water rights for the water necessary to satisfy the refuges' primary purposes. In addition, the Lower Klamath and Tule Lake refuges have water rights for irrigation of waterfowl habitat, based on a portion of the Project water right. In addition, and subject to the assumption by FWS of responsibility for the proportionate impacts to listed species, Reclamation also can continue to provide available Project water for beneficial reuse by the refuges to the extent of past and current usage and consistent with Project purposes.

2.3 DESCRIPTION OF THE PROPOSED ACTION

Reclamation proposes to continue operation of the features and facilities of the Klamath [Project consistent with the historic operation of the Project from 1961 to 1997.

The three primary Project reservoirs used for diversion, storage and delivery of water for Project purposes are Upper Klamath Lake and Clear Lake and Gerber Reservoirs. A detailed description of Project operations was described in Reclamation's 1992 BA (Reclamation 1992a). The November 2000 *Klamath Project Historic Operation* report (Reclamation 2000) also described Project features and their operation. This BA incorporates by reference the description of those facilities found on pages 11-30 of that report.

Major Project features include:

- Link River Dam on the Link River at the head of the Klamath River regulates flow from Upper Klamath Lake into the Klamath River, and water diverted from Upper Klamath Lake provides the majority of irrigation supplies for the Project lands. Reclamation contracted with PacifiCorp for construction of the Dam, which was completed in 1921. Most water storage occurs from October through April and delivery from storage April through September.
- Clear Lake Dam and Reservoir located on the Lost River in California. Reclamation is proceeding with a Safety of Dams (SOD) project at Clear Lake to correct known safety deficiencies of the dam. This project will be completed in 2002. The effects of the SOD project were described in an October 2000 environmental assessment and was the subject of a separate Section 7(a)(2) consultation completed in September 2001.
- Gerber Dam and Reservoir located on Miller Creek, a tributary of the Lost River in Oregon. The dam was constructed in 1925 and has a maximum surface area of 3,800 acres and capacity of 94,000 acre-feet.

Reclamation is proceeding with a feasibility study and NEPA process to raise Gerber Dam to provide additional storage for Project purposes.

- Malone Diversion Dam on the Lost River downstream from Clear Lake Dam in Oregon. Constructed in 1923, this small dam diverts water from Clear Lake into two canals in the Langell Valley Irrigation District. No water is stored and delivered during the fall and winter.
- Lost River Diversion Dam on the Lost River in Oregon that diverts excess water to the Klamath River through the Lost River Diversion Channel. This dam, constructed in 1912, has a primary purpose of flood control for the Project lands in the Tule Lake area.
- Anderson-Rose Dam on the Lost River diverts water for irrigation of California lands. Water originating from Upper Klamath Lake is diverted into the Klamath River and then the Lost River Diversion Canal. At Station 48, canal water is diverted into the Lost River and eventually flows to the Anderson-Rose Dam. Diversion for irrigation of Project lands in the Tule Lake area occurs from March through October.
- Tule Lake Tunnel that conveys drainage water from Tule Lake to Lower Klamath Lake was constructed in 1941. The Tunnel and associated Pumping Plant D was built in 1941. It also serves as a flood control and water delivery facility. It provides water for the Lower Klamath National Wildlife Refuge and Project lands in the Lower Klamath Lake area
- Agency Lake Ranch. Reclamation acquired Agency Lake Ranch in 1998 to store additional water for Project uses that would otherwise be spilled to the Klamath River during periods of high runoff. Reclamation diverts water onto the ranch when it is available and subsequently pumps that stored water into Agency Lake for Project purposes. In 2000, approximately 15,000 acre-feet of additional water were stored on the ranch.

Appendix A describes actions for consideration by the FWS and NMFS that may be used as elements of a reasonable and prudent alternative to the proposed action, if needed to avoid jeopardy to listed species; as elements of appropriate recovery plans for the listed species; or as voluntary conservation measures/actions to benefit the listed species. Reclamation anticipates that the United States will implement a water leasing and exchange program or water bank, a compensated demand reduction program, or other cooperative measures to address the needs of listed species in a manner that is consistent with Reclamation's contractual obligations. Consultation with the States of Oregon and California may also be required to assure that any necessary approvals are obtained. **These measures are not included in Reclamation's proposed action described in this BA.**

2.3.1 Water Storage and Delivery for Authorized Project Purposes

Reclamation proposes to deliver stored and diverted water from the Klamath and Lost River basins, first to irrigated lands as contracted, and second to satisfy refuge water rights in the Project area. In 2001, Reclamation analyzed historic water storage and delivery for authorized Project purposes using the KPOPSIM model, a spreadsheet model. The model is based on the historic hydrologic conditions from 1961 through 1997, using monthly time steps to define the output. That period includes full project development and a full range of water supply conditions. Completion of a biological opinion and identification of reasonable and prudent alternatives, if any, will further guide development of Reclamation's action before any action is actually implemented.

Table 2.1 displays the volumes of water storage and delivery for authorized Project purposes that would be available from Upper Klamath Lake for Project agricultural and refuge use under the proposed action. Water is diverted from Project storage facilities to provide for crop production and needs on national wildlife refuges located within the Project service area (Table 2.1).

Table 2.1 - Crop and Refuge Water Use from Upper Klamath Lake (1961 through 1999—values in 1,000s of acre-feet).							
Time Step	“Above Average” water year (19)			“Below average” water year (11)			
	Maximum	Minimum	Average	Maximum	Minimum	Average	

October	28.90	6.58	17.78	27.77	12.34	18.53
November	15.86	0.49	6.78	14.25	2.28	6.81
December	17.28	0.39	8.68	16.43	1.52	8.50
January	22.74	5.43	12.43	23.57	6.24	13.79
February	17.64	2.33	7.28	11.10	2.94	8.03
March	12.87	0.30	4.69	10.68	1.00	6.07
April	52.85	5.49	21.14	52.85	21.92	36.17
May	76.70	28.95	55.15	81.83	50.55	65.49
June	103.54	45.33	81.72	102.05	73.11	86.17
July	105.38	75.33	91.35	104.55	75.37	93.25
August	87.20	47.71	74.63	88.58	36.08	71.50
September	61.45	34.63	48.09	60.95	40.15	48.76
Time Step	“Dry” water year (5)			“Critical Dry” water year (2)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
October	29.13	8.83	20.50	31.17	14.62	22.90
November	16.52	1.50	6.15	9.51	5.57	7.54
December	17.09	6.15	11.99	20.33	15.26	17.80
January	20.67	9.33	13.72	19.70	11.14	15.42
March	17.99	1.75	10.15	16.30	11.07	13.69
April	67.32	27.11	41.53	63.63	57.64	60.64
May	58.73	37.60	50.47	90.12	51.50	70.81
June	91.75	70.99	81.70	87.66	78.67	83.17
July	99.81	87.40	95.28	103.77	58.25	81.01
August	83.48	76.26	79.37	90.84	64.91	77.88
September	66.07	49.63	58.56	33.46	32.15	32.81

In the “Effects of the Action” chapter of this BA, Reclamation provides information about the river flows and lake levels that will likely result from the proposed action in order to assist FWS and NMFS in developing coordinated biological opinions for the protection of the listed species. However, maintenance of precise lake levels and river flows are not the actions upon which Reclamation is consulting in this BA; rather they are an anticipated result of alternatives to the proposed action for which effects are evaluated.

2.3.2 Reduce Fish Entrainment into the A-Canal from Upper Klamath Lake and Provide Fish Passage at Link River Dam

1. Entrainment Reduction: Entrainment of endangered suckers and lack of connectivity between sucker populations have been identified as some of the major effects of Project operations. Reclamation has already begun a process to screen the A-Canal and provide adequate passage of these species at Link River Dam. Reclamation defers to the judgment of FWS with respect to the benefits of the screens. Based on prior recommendations by FWS that screens be installed, Reclamation proposes to prepare a multi-year plan to design and install screens and ladders at other diversions in the Project service area by January 1, 2003, for Service approval.

Reclamation will prepare final designs for a permanent fish screen at the A-Canal headworks by September 1, 2002. Construction is proposed to begin by December 1, 2002, and to be completed and operational by the beginning of the irrigation season on April 1, 2004.

2. Fish Passage at Link River Dam. Reclamation proposes to study and implement specific measures to provide fish passage at Link River Dam. Reclamation completed a draft conceptual Link River fish passage plan in May 2001 for Service review and comment. Final fish passage designs will be prepared by January 2004. Final design will be coordinated with the results of a two-year study starting in 2002. Reclamation anticipates that installation of fish passage will be completed within two years after approval of the final designs. Estimated completion date is January 2006.

2.3.3 Implement Klamath Basin Water Supply Enhancement Act (P.L. 106-498)

Reclamation proposes to undertake feasibility studies authorized by the Klamath Basin Water Supply Enhancement Act to study enhancing the water supply available for Project use. Such studies will include, but will not necessarily be limited to: (1) increasing the water storage capacity of Gerber Reservoir and Upper Klamath Lake; (2) developing off-stream water storage in the Lower Klamath Lake area; and (3) a water storage leasing program. Implementation of actual projects and/or programs would be contingent upon the results of the feasibility studies, Congressional approval, authorization, and appropriation, and completion of appropriate environmental compliance activities.

2.3.4 Operation of Klamath Basin National Wildlife Refuge Complex

This complex of national wildlife refuges includes Tule Lake, Lower Klamath Lake, Upper Klamath Lake and Clear Lake National Wildlife Refuges. These refuges are under the jurisdiction of the FWS and their operation is subject to the FWS management and control. This assessment describes only those effects upon the refuge complex that result from operation of the Klamath Project and not the effects of refuge operation. For the purposes of this BA only, Reclamation has included the effects of water use on these refuges within the effects of the Klamath Project as interrelated and interdependent activities.

CHAPTER 3.0 - LISTED SPECIES POTENTIALLY AFFECTED BY THE PROPOSED ACTION

3.1 LISTED SPECIES FOUND IN ACTION AREA

The Southern Oregon/Northern California Coast coho salmon (SONCC) Evolutionary Significant Unit (ESU) (*Oncorhynchus kisutch*) was listed as threatened under the ESA on May 6, 1997. The listing of these stocks was the response of NMFS to abrupt declines in their abundance, particularly during the last decade. The designation of critical habitat for the stocks within the above-mentioned ESU followed in May 1999. The Lost River sucker (LRS) (*Deltistes luxatus*) and shortnose sucker (SNS) (*Chasmistes brevirostris*) were listed as endangered on July 18, 1988. Critical habitat for the endangered suckers was proposed December 1, 1994. A final designation has not been made.

The bald eagle (*Haliaeetus leucocephalus*) was listed as endangered in most states and as threatened in Oregon on February 14, 1978. Due to range-wide trend of increasing populations, the bald eagle was proposed for delisting in 1999. No final status has been determined. There is no critical habitat designated for bald eagles.

3.2 BALD EAGLE

3.2.1 Background

The bald eagle is a generalized predator/scavenger primarily adapted to edges of aquatic habitats. It weighs up to 12 pounds and has a wingspan of 6-7 feet. Its primary foods are fish, waterfowl, carrion, and small mammals. The species is long-lived, and individuals do not reach sexual maturity until 4 or 5 years of age. Bald eagles nest in large trees near and usually within sight of large bodies of water. Nests are constructed of large sticks, are typically about 4 feet wide and 3 feet deep. Often eagles have an additional alternate nest in their territory. They can occupy nesting territories and nests for twenty or more years. Eagles generally mate for life but will replace lost mates readily. Eagles lay an average of 1-3 eggs. If adequate prey is not available during brooding, only the largest nestling may survive. Young fledge (first fly) in approximately 10-12 weeks by may take another 4 weeks to become proficient at flight. Within several weeks of flight proficiency the young are generally self-sufficient and can find food on their own, though they often remain near their parents nesting territory.

Bald eagles require year-round access to food. Bald eagles that occupy nesting areas without winter access to food migrate from nesting areas to wintering areas with accessible food and night-roosting shelter for thermo-regulation and protection from disturbance. Immature or non-breeding adults often spend a longer period at wintering areas than do breeding adults.

During the late fall and winter, as many as 1,000 bald eagles from throughout the Pacific Northwest, western states and Canada migrate into the Upper Klamath Basin. The Klamath Basin contains approximately 25% of the nesting bald eagles in Oregon. Nests are widespread in the basin and are found at most of the Project reservoirs. Upper Klamath Lake has more than 20 nesting pairs of bald eagles.

More detailed information on description, life history, historic abundance, and distribution of the bald eagle were described in the February 13, 2001 BA and April 5 BO.

3.3 LOST RIVER AND SHORTRIVER SUCKERS

3.3.1 Background

Historically, Lost River and shortnose suckers were abundant in Upper Klamath Lake and were utilized as a subsistence fishery by the Klamath Tribes. In the 1900's, the suckers were subjected to a snag fishery on spawning adults. Over the period from 1966 to 1986, the annual harvest of fish declined 95 percent from about 12,500 to 687

fish and several spawning groups went extinct. In 1988, when the species were listed as endangered the Williamson River/Sprague runs were estimated at less than 12,000 Lost River suckers and less than 3,000 shortnose suckers. Little information was known about the status of suckers in other Upper Klamath Basin lakes (USFWS 1994).

Both suckers are long-lived, up to 43 yr (LRS) and 33 yr (SNS), with a reproductive lifespan for females beginning at 6-9 yrs (LRS) and 4-7 yrs (SNS). Females produce 50,000 to 200,000+ eggs per spawning season. Spawning may not occur every year particularly for females (Perkins et al. 2000).

Both species of suckers are lake dwelling but spawn in tributary streams or shoreline springs. Sucker spawning can begin as early as February and continue through May. Tributary spawning generally occurs in riffle areas with moderate current and gravel/cobble substrate. In Upper Klamath Lake sucker spawn in shallow water at shoreline spring areas with coarse substrate.

The small eggs hatch in about 1-2 weeks and then remain in the substrate for another week. After absorbing most of their yolk, the larvae swim out of the gravel and migrate downstream (Buettner and Scopettone 1990).

Larval suckers produced at lake shoreline and tributary stream spawning areas may be present from March through July (Simon et al. 1996). The larvae produced in tributaries usually spend relatively little time there and migrate back to the lake shortly after the hatch. Larval sucker migration from the spawning areas can begin as early as March but mostly occurs during May and June for Upper Klamath Lake. Larvae appear to be dependent on shallow shoreline areas; particularly those vegetated with emergent wetland plants (Cooperman and Markle 2000).

Larvae grow into juveniles (age 0) during the summer (usually by July) where they continue to occupy shoreline habitats in UKL including emergent vegetation, and unvegetated areas particularly those with clean gravel and cobble substrates but not fine silty bottoms. In late summer and early fall age 0 juveniles continue to occupy shoreline areas but also utilize open water habitat where all substrates are fine silts. Emergent vegetation is absent from some lakes supporting suckers including Clear Lake and Gerber Reservoir where juveniles occupy shoreline and open water habitats.

Older juveniles and adult suckers are found in open water areas typically at depths of greater than 3 feet (Peck 2000). In Upper Klamath Lake they are mostly concentrated in the upper portion of the lake. During periods of poor water quality (low dissolved oxygen and high temperature, pH, and unionized ammonia) in UKL, many adult suckers occupy areas of better water quality adjacent to inflowing tributary streams and groundwater springs particularly near Pelican Bay.

Poor water quality has been implicated as a cause of fish kills in 1995, 1996, and 1997 in UKL (Perkins et al. 2000). The ultimate cause of the UKL water quality problem is excessive nutrients, especially nitrogen and phosphorus, due to natural inputs, external sources and internal loading. Sediment cores show increases in the sediment accumulation rate, nitrogen and phosphorus concentrations, and a shift toward the nuisance algae responsible for existing poor water quality over the last 50-100 years (Eilers et al. 2001).

Recent sucker information on biology, distribution and abundance, age and growth, habitat, water quality, entrainment, and genetics was described in the February 13, 2001 BA. Most of the pertinent habitat, fish population and water quality monitoring data collected in 2001 has not been reported yet.

3.2.2 New Information Related to Current Status

In 2001, adult population monitoring was conducted at the Chiloquin Dam fish ladder, lower Williamson River, shoreline spawning locations, and stations around UKL by USGS-Biological Resources Division (R. Shively, BRD, per. com.). Although sampling effort increased from 33 days in 2000 to 40 days in 2001, the total number of suckers captured in the ladder decreased from 1,576 to 697. The majority of the suckers captured were Klamath

largescale (48%) and Lost River suckers (42.5%), followed by shortnose suckers (3.5%) and undetermined species (6.0%). Large portions of suckers captured in the ladder in 2001 were untagged. Sixty-three suckers were recaptured mostly from prior years' sampling efforts at the ladder.

The longest and most consistent adult monitoring program has occurred in the lower Williamson River from 1995 through 2001 (Shively et al. 2000). In 2001, sampling occurred from February 13 to June 1 at four fixed locations. A total of 1,329 suckers were captured including 922 shortnose suckers, 281 Lost River suckers, 73 Klamath largescale suckers and 49 fish with intermediate characteristics. Abundance index values were computed using catch rate data for the entire season allowing for comparison between years. The Lost River sucker index value was 16.5, the highest value since 1995 (35.5). The shortnose sucker index value was 37.4 which is higher than 1997-2000 (8.7-26.8) but lower than 1995 (258.8) and 1996 (119.2). One important consideration of these data is the relatively high percentage of spent fish captured in 2001. Approximately 50% of the shortnose and 25% of Lost River suckers were classified as spawned out. However, there appears to be a general increasing trend in abundance index values for both species since 1998 following the three fish kill years (1995-1997). This trend may be related to more complete recruitment of the 1991 and 1993 year-classes.

Shoreline spawning areas in UKL were sampled from mid-February through May 2001. A total of 1,553 Lost River and 30 shortnose suckers were captured. The overall catch of Lost River suckers was higher than in 2000 (1,258) but lower for shortnose suckers (68). A total of 201 Lost River and 10 shortnose suckers were captured that had been originally tagged in previous years' sampling. Most tagged fish were originally tagged and recaptured at shoreline spawning locations. Length frequency of male and female Lost River suckers sampled from shoreline areas had a similar pattern as the previous two years with a slight shift to the right. This suggests that the age class distribution may have not changed much for shoreline spawning groups. There does not appear to be major recruitment of younger age classes into the spawning population.

Additional sampling of adults occurred at 27 different locations in UKL from mid-February to June. A total of 1,237 suckers were collected with over half being captured in the Modoc/Goose Bay area. Most fish were identified as shortnose suckers (626) or Lost River suckers (422). There were also 81 Klamath largescale suckers and 65 fish with intermediate characteristics between those species. The majority of the male Lost River and shortnose suckers were captured in "ripe" (ready to spawn) condition, while most females were either in a "pre-spawn" state or spawning condition was not apparent. After April 30, the majority of all suckers were found to be in a "spent" (spawned out) condition.

Oregon State University monitored relative abundance of age 0 suckers in 2001. Annual year class strength indices for age 0 shortnose suckers were the lowest for 2001 in August and September and 2nd lowest in October for the period 1995-2001 (D. Simon, OSU, per. com.). For age 0 Lost River suckers, 2001 ranked fourth out of 5 years, fourth out of 7 years in September and October. The low apparent recruitment in 2001 appears to be related in part to relatively poor spawning success since larval and early juvenile catch rates in spring and early summer were low.

Reclamation monitored water quality at several fixed sites in UKL from April through November using Hydrolab datasondes. Water temperature, dissolved oxygen, and pH was similar to that monitored during previous years (1992-2000). Dissolved oxygen and pH varied consistently with the state of blue-green algae growth in UKL. During June and July large amounts of *Aphanizomenon* were present leading to photosynthetically elevated pH (>9). During August and September algal decay cycles dominated resulting in lower pH (7-8) and dissolved oxygen values (3-5 mg/l). Stressful levels of pH (>9) and dissolved oxygen (<5 mg/l) occurred throughout most of the summer consistent with data from prior years. Extremely low dissolved oxygen concentrations (<3 mg/l) were measured at individual stations for short periods of time (< 1 week). Extended periods of windless or low wind days associated with previous fish die-off events did not occur in 2001. Only localized fish kills of sculpins and small chubs were documented by BRD and Oregon State University (OSU) field crews during the summer. No sucker die-offs occurred.

No sucker monitoring was conducted in Gerber Reservoir, Clear Lake, Tule Lake and the Lost River in 2001. OSU collected sucker larvae at a few locations in Lake Ewauna in 2001 but were unsuccessful in capturing juvenile suckers later in the summer.

3.2.3 Additional Review

One scientific review was conducted by the University of California, Davis (UCD) of the 2001 Biological/Conference Opinion regarding the effects of operation of the Bureau of Reclamation's Klamath Project on the endangered Lost River sucker and shortnose sucker, threatened bald eagle, and proposed critical habitat for the Lost River/shortnose suckers (UCD 2001). The UCD review concluded, "The 2001 BO for suckers uses available data which generally supports its recommendations. The recommendation to maintain higher lake levels is sound, although this measure may not result in enhanced survival of the endangered suckers. Clearly much is unknown about the endangered suckers in the Klamath Basin and additional study is needed to better manage the Basin to ensure the long-term survival of the endangered Lost River and shortnose suckers, agriculture and wildlife in this important ecological region."

The National Research Council also has initiated a scientific review. A brief interim report is scheduled for completion by January 31, 2002, with a final report due March 30, 2003. The interim report will focus on the February 2001 BAs of the Bureau of Reclamation and the April 2001 biological opinions of the U.S. Fish and Wildlife Service and National Marine Fisheries Service regarding the effects of operations of the Bureau of Reclamation's Klamath Project on listed species.

3.2.4 Klamath Water Users Association Report

In March 2001, the Klamath Water Users Association completed a document titled, "Protecting the Beneficial Uses of Waters of Upper Klamath Lake: A Plan to Accelerate Recovery of the Lost River and Shortnose Sucker." This report was released after the 2001 BA was completed in February 2001. The USFWS reviewed the document and incorporated pertinent information in the April 2001 BO. Reclamation has reviewed the document and has determined that most of the information pertinent to this BA has been cited previously. The Plan provides potential sucker recovery actions that Reclamation or other entities could implement to conserve the species. In fact, Reclamation has been pursuing a pilot oxygenation project on UKL to provide additional water quality refuge habitat for endangered suckers.

Additional information on the current status of the endangered Lost River sucker and shortnose sucker is found at the end of Chapter 4.0 (section 4.5.1)

3.3 COHO SALMON

3.3.1 Background

During the twentieth century, naturally produced populations of coho salmon have declined or have been extirpated in California, Oregon, and Washington. Limited information is available on historical coho salmon abundance in the Klamath River Basin. In 1983, the estimated spawning escapement was 15,000-20,000 which included hatchery stocks and were less than six percent of their estimated abundance in the 1940's. Klamath and Trinity Basin coho salmon runs are now composed largely of hatchery fish, although there may be wild runs remaining in some tributaries.

Coho salmon are anadromous salmonids that typically exhibit a 3-year life cycle almost equally divided between the freshwater and the sea phase. In the Klamath system coho normally spawn in tributary streams from November through February peaking in January. Some spawning occurs in the mainstem Klamath River in gravel/cobble riffle areas with moderate current.

Once spawning is complete, eggs incubate in the gravel for about 7 weeks before hatching. The time for egg incubation in the Klamath system is from November through March. Fish remain in the gravel as fry for about 2-3 weeks until the yolk is absorbed, then emerge as free-swimming actively feeding fry. Emergence typically occurs from February to mid-May.

Most coho salmon young remain in freshwater for at least one year before migrating to the ocean. Juvenile coho

will initially take up residence in shallow, gravel areas near the streambank. Later in the summer fish will move into deeper pools seeking slow moving water and structure for cover. Coho fry are present in the mainstem Klamath River from at least April through late July and coho yearlings from mid-March through August. Coho salmon juveniles likely rear year-round in the mainstem.

Klamath River basin coho out-migrate from February through June with a peak usually in May. Peak numbers of coho smolts generally arrive in the Klamath River estuary in April and May. The number of fish declines to lower levels after May and remain low until October or November. Coho captured in the spring were smolts while fish captured in the fall were juveniles.

The major factors identified as responsible for the decline of coho salmon in the Klamath River Basin include logging, road building, grazing, dams, water withdrawals and unscreened diversions for irrigation. Other factors include mining, harvest, predation by seals and sea lions, hatchery practices, and mining.

More detailed information on description, life history, historical abundance and distribution for SONCC coho salmon addressed in this BA were described in the January 22, 2001 BA.

3.3.2. New Information Related to Current Status

New information related to the current status of coho salmon is found at the end of Chapter 4.0 (section 4.5.2).

CHAPTER 4.0 - ENVIRONMENTAL BASELINE

4.1 INTRODUCTION

This chapter on the environmental baseline describes the impacts of past and ongoing human and natural factors leading to the present status of the species and its habitat within the action area. The environmental baseline provides, in effect, a “snapshot” of the relevant species’ health at a specified point in time (i.e. the present). It does not include the effects of the discretionary action proposed in the current consultation, but it does include past and present impacts of all federal, state, or private actions and other human activities in the action area. 50 CFR § 402.02. For purposes of this BA, the current effects of all past activities include those associated with construction of the Project, historic operation of the Project, and the associated natural environment. The baseline also includes State, tribal, local, and private actions already affecting the species or habitat in the action area or actions that will occur contemporaneously with the consultation in progress. The environmental baseline assists both the action agency and the Services in determining the effects of the proposed action on the listed species.

4.2 PAST AND PRESENT IMPACTS OF ALL FEDERAL, STATE OR PRIVATE ACTIONS AND OTHER HUMAN ACTIVITIES IN THE ACTION AREA

4.2.1 IMPACTS ON SUCKERS

1. Impacts of Lake Modifications

Historically, Lost River and shortnose suckers occupied four lakes--Clear Lake, Tule Lake, Upper Klamath Lake, and Lower Klamath Lake--and their associated tributaries in the Upper Klamath Basin. Watershed development, including construction of the Klamath Project, associated agriculture and refuge development, and construction of dams on the Klamath River for hydroelectric power, substantially changed sucker habitat. New sucker habitat was created as a result of construction of Gerber, J.C. Boyle, Copco, and Iron Gate and sucker habitat at Clear Lake has expanded over time as a result of watershed development. In contrast, major reductions in habitat occurred at Tule Lake (75-90 percent reduction from pre-development levels) and Lower Klamath Lake (97 percent reduction). Moderate reductions (20-30 percent) in sucker habitat have occurred in Upper Klamath Lake.

Table 4.1 illustrates the changes in lake size in the Klamath Basin related to watershed development. Changes in lake size result in commensurate changes in available sucker habitat. In the late 1800s, prior to most watershed development, approximately 223,000-330,000 acres (276,000 average) of shallow lake and associated wetland habitat existed compared to 76,000-122,000 acres (99,000 average) now. Overall, suckers’ lake habitat has decreased approximately 64 percent (177,000 acres) over the last century. A concurrent, substantial decline in sucker populations over this time period was related in part to the large loss of lake and wetland habitat areas, but was also attributable to suckers’ blocked access to spawning and rearing areas and entrainment losses resulting from diversions. The following section discusses changes in habitat and impacts on suckers at each of the lakes.

Table 4.1 - Changes in lake size in the Klamath Basin related to watershed development.

Water Body	Historic size (acres)	Present size (acres)
Upper Klamath Lake	78,000-111,000	55,000-77,593
Lower Klamath Lake	85,000-94,000	4,700
Clear Lake	15,000	8,500-25,760
Tule Lake	55,000-110,000	9,450-13,000
Gerber Reservoir	--	1,076-3,870
J.C. Boyle Reservoir	--	420
Copco No. 1 Reservoir	--	1,000

Copco No. 2 Reservoir	--	40
Iron Gate Reservoir	--	944
TOTAL	233,000-330,000	81,130-127,327

Upper Klamath Lake

Upper Klamath Lake was modified when PacifiCorp (formerly COPCO) constructed Link River Dam in 1921 and cut a channel through the rock reef at the lake outlet as part of the Project. Water levels historically ranged from about 4140 feet to 4143 feet, but fluctuated between 4137 and 4143 after the Project was developed. During years when lake levels dropped below 4140, less shoreline spawning and larval and juvenile rearing habitat were available, juvenile and adult open water habitat, and water quality refuge habitat. This may have resulted in smaller sized year classes and an increased risk of fish kills leading to overall declines in sucker populations.

Historically, 111,000 acres of lake and marsh habitat existed at pre-development maximum elevation, compared to 78,000 acres now (30 percent reduction). Private, non-Project agricultural development by landowners around Upper Klamath Lake accounted for all of this reduction in available sucker habitat. The reduction in marsh habitat may have resulted in lower survival of larval and juvenile suckers and smaller sized year classes. Smaller year classes would then result in lower overall sucker populations.

Clear Lake

Historically, Clear Lake was approximately 15,000 acres with about 5,000 acres of wetlands (4523 ft). Clear Lake Dam was constructed as part of the Project in 1910 increasing the storage capacity, depth and area of this lake. At maximum elevation (4543), the lake covers 25,760 acres, an increase of approximately 10,000 acres (66%). At a minimum elevation of 4519, the surface area of the lake is 8,500 acres. At an elevation of 4528 (average post-project elevation), there are 21,200 acres of lake habitat, representing a 41% increase in area over the pre-Project area. Wetlands are currently absent from Clear Lake due to substantial fluctuations in water levels associated with Project operation. With more lake habitat and better access to spawning tributaries, sucker populations likely increased substantially as a result of Clear Lake Dam construction.

Tule Lake

Pre-development, Tule Lake varied substantially in size due largely to its connection with the Klamath River (55,000-110,000 acres). During high runoff periods, water from the Klamath River flowed into the Lost River Slough and down the Lost River to Tule Lake. Much of the historic Tule Lake lakebed was reclaimed for Project agriculture development during the first 60 years of the twentieth century. Present shallow lake and marsh habitat in two sumps (1A and 1B) range from 9,450-13,000 acres.

In 2000, Sump 1B (3,550 acres) was drained as part of a wetland restoration project by the U.S. Fish and Wildlife Service (Tule Lake National Wildlife Refuge). Plans are to reconnect it to Sump 1A in a few years, after the emergent marsh has become well established. The U.S. Fish and Wildlife Service also manages another 640 acres of demonstration and experimental marshes and 17,500 acres of agricultural lease lands that were lake habitat before most of Tule Lake was drained. Sucker populations that likely numbered in the hundreds of thousands if not millions declined to extremely low numbers as a result of draining most of Tule Lake for agricultural development. Not only was the lake habitat reduced to a fraction of its former size, but also access to historic spawning areas was blocked by Project diversion dams.

Lower Klamath Lake

Lower Klamath Lake once covered 85,000-94,000 acres but included only about 30,000 acres of open water habitat. Agricultural and refuge development associated with the Project eliminated most of this habitat. Currently, there are only 4,700 acres of permanently-flooded open water and wetland habitat. This includes about 2,475 acres in Keno Reservoir (Lake Ewauna and Klamath River to Keno Dam), with the remainder in Lower Klamath National Wildlife Refuge (2,225 acres). The U.S. Fish and Wildlife Service also manages 21,105 acres of wetlands and 14,400 acres of agricultural lease and cooperative farmland that were part of pre-Project Lower Klamath Lake.

Draining and reclaiming of most of Lower Klamath Lake resulted in the extirpation of sucker populations in Lower Klamath Lake. The remaining open water habitat is too shallow to support suckers

Gerber Reservoir

Gerber Reservoir was constructed in 1926 as a storage reservoir in the Project. Prior to its construction, there were approximately 3,500 acres of seasonal wetlands but no permanent lake habitat. At maximum elevation of 4836, there are 3,870 acres. At a minimum elevation of 4802 (2001 BO minimum) and average elevation of 4815 there are 1,076 and 2,520 acres respectively. Historic wetland habitat was transformed to deep open water habitat. No shoreline wetlands are present due to large fluctuations in water level. Construction of this dam resulted in the expansion of shortnose sucker populations in the Lost River watershed. A relatively large population of suckers has become established where none existed before the dam was built.

Additional lake habitats that support sucker populations were developed along the Klamath River as part of the PacifiCorp Hydroelectric Project. Four reservoirs were constructed, including J.C. Boyle, Copco 1 and 2, and Iron Gate, which are 420, 1000, 40, and 944 acres respectively. No lake habitat existed in the Klamath River below Keno historically. Suckers populations have expanded into these lake habitats. However, it appears that only those in J.C. Boyle are self-sustaining. Fish in the other reservoirs likely moved from upstream areas. Populations are generally small compared to those in Upper Klamath Lake, Gerber Reservoir, and Clear Lake. Resident sucker populations have also become established in impounded areas of the Lost River including Wilson Reservoir (1912; Project dam) and Harpold Reservoir (1924; Horsefly Irrigation District).

2. Impacts of Upper Klamath Lake Modifications

Extensive reclamation of lake peripheral wetlands has occurred over the last century due to private non-project agricultural development (Table 4.2). The littoral wetland area of the lake once comprised 51,510 acres (46 percent) of the total lake area of 111,510 acres at maximum elevation (Geiger 2001). The historical records of lake fluctuation prior to construction of the Link River Dam in 1921 document the lake fluctuating between a maximum of 4143.0 and a minimum of 4140.0. Following dam construction and after the last diking and draining of wetlands in 1968 (Snyder and Morace 1997), the lake area at maximum elevation of 4143.3 had decreased to 77,590 acres, and littoral marsh area decreased to 17,370 acres (22% of the total lake area). The lake lost 30% of its area and the associated lake volume through diking and draining. The in-lake wetland area was reduced by 66% (34,000 acres). In addition, there was a reduction of littoral lake volume from 82,000 af to 28,000 af; a 66% reduction. The major loss of wetland habitat has impacted larval and juvenile suckers the most, since these life stages generally occupy shallow shoreline areas.

Historic operation of the Project has resulted in occasional lowering of Upper Klamath Lake levels to 4137.0 compared to 4140.0 before Link River Dam was constructed. The wetland area inundated at the pre-dike, pre-dam minimum of 4140.0 was 20,300 or 40% of the wetland area inundated at maximum elevation. Post-project wetland area inundated at maximum elevation is 17,370 acres versus approximately 500 acres at minimum elevation of 4137.0 (3%). Open water area was the same at maximum elevation before and after Project construction (60,000 acres, 4143.3). At the pre-dam minimum elevation of 4140.0 there were 47,400 acres of open water area compared to 55,800 acres after diking and dam construction (4137.0). This change represents a 7% increase in open water area at minimum lake elevation. During years when the lake is lowered below 4140, sucker habitat has been reduced, leading to lower survival of all sucker life stages. The lower levels also increased the risk of poor water quality and increased the risk of fish kills. Overall, sucker populations may have declined as a result of these lake level operations.

Table 4.2 - Wetlands adjacent to Upper Klamath Lake converted to agricultural land¹.

Site	Acres	Date Converted	Acres (cumulative)	Percent (cumulative)
Wilson Marsh	100	1889	100	0.1
Little Wocus Marsh	260	1889	360	1.3
Big Wocus Marsh	3,800	1896	4,160	15.7

Algoma Marsh	1,200	1914	6,660	25.1
Caledonia Marsh	2,500	1916	7,860	29.6
Hanks Marsh (Cove Point)	1,000	1919-40	8,860	33.3
Ball Bay South	800	1919	9,660	36.3
Williamson River Marsh	6,400	1920	16,060	60.4
Wood River Ranch	2,900	1940-57	18,960	71.4
Ball Bay West	410	1946-47	19,370	72.9
Agency Lake North	2,600	1962	21,970	82.7
Agency Lake West	4,600	1968-71	26,570	100
¹ Approximately 8,000 acres, primarily in the Wood River watershed, were converted but are not accounted for in this table.				

Not only has non-Project development resulted in a loss of lake surface and wetland area, the most important wetland areas providing sucker habitat in the lower reaches of the Williamson River and in UKL near the Williamson River mouth are now thin bands of vegetation perched at relatively high elevations adjacent to dikes. While approximately 100% of the marsh habitat is available in undisturbed marsh areas at 4142, the marsh habitat in the lower Williamson River and in the lake near the mouth of the Williamson River is diminished by about 50%. This difference in habitat inundation is essentially due to the difference in width and elevation gradient between the northern marshes and the narrow shoreline marshes near the Williamson. As a result of wetland habitat loss and the remaining habitat's high elevation, any lowering of the lake has reduced the amount of larval rearing habitat. Survival of larval suckers has probably been lower and resulting year classes smaller.

Major modifications were made to the major UKL stream/river deltas (Williamson River, Wood River, Seven Mile Creek, Four Mile Creek) through private agricultural development during the 20th century. Wetland areas near the mouth of these tributaries were diked and drained, and approximately 20 miles of narrow meandering river channels were straightened, rerouted, widened and disconnected to adjacent wetlands. Riparian corridors lined with willows and cottonwood trees were cleared. The delta areas performed several important ecosystem functions including providing passage corridors for migrating fish, nursery habitat for larvae and juvenile suckers, rearing and feeding areas for juveniles, refuge habitat for juvenile and adult suckers during periods of poor water quality in UKL and water quality improvement by nutrient and sediment removal in the wetlands.

Tributary delta restoration has been conducted by the Bureau of Land Management during the last five years on the Wood River and pilot river restoration has been initiated on the Williamson River by the Nature Conservancy. This has improved emergent vegetation habitat in these rivers, benefiting larval sucker survival.

Historically, there were many shoreline springs that were important spawning areas for Lost River and shortnose suckers including Barkley Springs, Odessa Springs, Harriman Springs, Sucker Springs and several others along the east side of UKL. Sucker spawning currently occurs at only a few areas including Sucker Springs, Silver Building Springs, Ouxy Springs, Cinder Flat and Boulder Springs. Spawning substrate was added to Sucker Springs and Silver Building Springs in the 1980s by several entities to improve spawning success. These additions were made at relatively high elevations along the shoreline. Harriman Springs on the west side of Upper Klamath Lake was degraded by increased sedimentation resulting from watershed activities including: logging, grazing, residential development and channelization of Four Mile Creek. Barkley Springs were extensively modified by a park development. Harvest of suckers also reduced population levels at several of these springs. Shoreline spawning success has been substantially reduced by this habitat degradation leading to smaller year classes and smaller overall sucker populations. Unique spawning stocks were extirpated at some locations.

Shoreline spawning habitat at springs along the eastern shoreline of UKL was negatively impacted by construction of the railroad about 1915 along the shoreline between Modoc Point and Algoma (about 5 miles). Natural cobble and gravel shoreline substrate was covered with large boulder riprap. Substrate recruitment from the steep escarpment has been eliminated.

Upper Klamath Lake tributaries, important spawning habitat for suckers, have been dramatically altered over the last century by non-project land use practices in the watershed. Agriculture, grazing, logging, road construction, flood control projects and residential development has resulted in degradation of over 100 miles of historic sucker spawning and rearing habitat along the Williamson River, Sprague River, Wood River, Seven Mile Creek and Four Mile Creek. Sucker spawning and rearing habitat alterations include increased sedimentation and nutrient loading, increased temperatures, channel modifications (diking, straightening, widening, deepening), loss of riparian vegetation, flow reductions and changes in the hydrograph (steeper with higher peak flows and lower minimum flows). Due to degraded habitat conditions in the tributaries spawning success was likely less resulting in smaller sized sucker populations. Increased nutrient loading led to larger algae blooms and associated poor water quality. With poor water quality, fish health was impaired and fish kills more frequent resulting in smaller sucker populations.

3. Impacts of Water Diversions and Diversion Structures

Irrigation, recreation, fish and wildlife, and power production are the major uses of surface water in the Upper Klamath Basin. Domestic, municipal, and industrial uses are small in relation to basin yield. Over 95% of the consumptive use of water in the Klamath Basin is for agricultural purposes. (Oregon State Water Resources Board 1971).

Approximately 240,000 acres of irrigable agricultural lands are within the Project service area. An average of about 200,000 acres of Project lands are currently being irrigated. Irrigable lands above the Project include about 25,000 acres in the Lost River watershed (Reclamation 1970a, 1970b) and 150,000 acres in the Upper Klamath Lake watershed (Risley and Leanen 1999; Geiger et al. 2000). Over 100,000 acres of irrigable lands are located in the Sprague River and Williamson River watersheds above Upper Klamath Lake. The diversion of water, and resultant flow depletion, for these consumptive uses affect habitat for endangered suckers. Impacts include reductions in and degradation of spawning and rearing habitat, water quality degradation, entrainment, isolation of populations, and increased risk of hybridization. All have contributed to the decline in sucker populations

Table 4.3 - Annual non-project irrigated land acreage permitted by the Oregon Dept. of Water Resources in the Williamson River basin, Oregon (Risely and Leanen 1999)

YEAR	ACRES
1880	5,000
1890	7,000
1900	10,000
1910	15,000
1920	17,000
1930	30,000
1940	32,000
1950	33,000
1960	50,000
1970	75,000
1980	100,000
1990	110,000

4. Barriers to Upstream Passage

Dams block sucker migration corridors, isolate population segments, concentrate suckers in limited spawning areas increasing the likelihood of hybridization between species, may result in stream channel changes, and alter water quality and provide habitat for exotic fish that prey on suckers or compete for food and habitat with them. There are

seven major Project dams that affect the migration patterns of listed suckers including Clear Lake, Tule Lake, Link River, Gerber, Malone, Miller Creek, Wilson, and Anderson-Rose. Only Link River Dam has a fish ladder and it is inadequate for sucker passage. There are at least 16 non-project dams that block or restrict upstream access for suckers within the range of the endangered suckers.

The most significant non-project dam with inadequate upstream passage facilities within historic sucker habitat is the Sprague River Dam (Chiloquin Dam), located 12 miles upstream of UKL. This dam has a partially effective fish ladder that is negotiated by some endangered suckers. There are approximately 60 miles of proposed critical habitat in the Sprague River above the dam.

In the Gerber Reservoir watershed, fish passage is restricted at Dry Prairie Dam on Ben Hall Creek (tributary to Gerber Reservoir). This earthen dam located on private and U.S. Forest Service lands blocks access to about 5 miles of potential shortnose sucker spawning and rearing habitat.

Above Clear Lake on Willow, Boles, and Fletcher creeks there are at least 43 small earthen dams on U.S. Forest Service and private lands that potentially restrict access to upstream sucker habitat. The dams most likely to restrict sucker passage include Boles Meadow, Fletcher Creek, Avanzino, Weed Valley, and Fourmile Valley. They restrict access to a total of about 20 miles of stream habitat.

Other private or irrigation district owned flash-board diversion dams on the Lost River lacking fish passage facilities include: Bonanza Diversion Dam, Harpold Dam, Lost River Ranch Dam which restrict upstream passage to 20, 4, and 5 miles of stream/reservoir habitat during the spring and summer. These dams are removed from October until April allowing access to these areas during the fall and winter.

PacifiCorp owns and operates five dams on the Klamath River including Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate. No fish passage facilities are present at Iron Gate, Copco 1 and Copco 2 dams. Fish ladders are present at J.C. Boyle and Keno dams but they are inadequate for sucker passage. Access to about 54 miles of river habitat is blocked or restricted by these dams.

Several removable fish ladders have been installed at irrigation diversion dams in the Wood River Valley along the Wood River and Seven Mile Creek. It is not known if these ladders are passable by endangered suckers.

Overall non-project dams block or restrict upstream passage and connectivity to approximately 175 miles of stream spawning and rearing habitat. Project dams block access to approximately 100 miles of stream habitat. These dams have prevented fish from migrating to historic spawning and rearing areas, leading to resulting in lower spawning success and survival of all life stages.

5. Unscreened Diversions

Unscreened or ineffectively screened diversions have caused serious fish losses. A historic study on a tributary of the Scott noted that an unscreened ditch was drained in June and the stranded fish were counted: 1,488 young steelhead and 105 young coho salmon (Taft and Shapovalov 1935). As recently as March 1988, a major irrigation ditch was opened in the Scott Valley without the fish screen installed and an unknown amount of young fish were lost (R. Dotson, CDFG, personal communication). The fish diverted into ditches are either delivered with the water onto fields, or die in the ditch when the water is shut off in the fall.

Reclamation identified 221 diversions within the Project service area including Upper Klamath Lake that are directly connected to endangered sucker habitat (Reclamation 2001; Table 4.4).

Table 4.4 - Diversions within the upper Klamath River basin that potentially entrain endangered suckers (not including the Sprague or Wood Rivers).

Owner	Number	% (no.)
Private	165	75
Irrigation districts	26	12
Reclamation	16	7
State	8	4
USFWS	5	2
BLM	2	1
TOTAL	221	100

Reclamation has only 16 diversions (7%) but has the highest potential entrainment because most diversions are large gravity and pump diversions delivering water to approximately 200,000 acres of agricultural lands. There are about 165 private diversions or 75% of the total number of diversions. Most are small pump diversions delivering water to relatively small parcels of land. Irrigation district diversions make up 12% of the total number.

Diversions around Upper Klamath Lake have the highest potential to entrain suckers because they are adjacent to river and lake shoreline habitats that have relatively high densities of suckers. There are about 25 diversions around UKL including the lower reaches of the Wood River, Seven Mile Canal, and the Williamson River. Reclamation has the largest diversion serving 7,200 acres (Agency Lake Ranch). This 100 cfs diversion was screened in 2001. The remaining 24 diversions diverting water to approximately 23,000 acres of agricultural lands and managed wetlands are unscreened.

The largest source of sucker entrainment is at the A-Canal at the lower end of UKL. This Project facility constructed in 1906 diverts 400-1000 cfs during the April through October irrigation period. In 1996 and 1997 entrainment estimates were 3 and 1.7 million sucker larvae, respectively (Gutermuth et al. 2000). Juvenile and adult sucker entrainment estimates were 47,000 in 1997 and 250,000 in 1998. Reclamation is currently developing designs for a fish screen facility to be installed by April 2004.

Entrainment itself accounts for a substantial component of the age 0 juvenile mortality in UKL (USFWS 2001). Large numbers of suckers are entrained at the Eastside and Westside diversions at Link River Dam each year. Fish entrainment at the two hydropower diversions on Link River Dam (PacifiCorp) was 21,000 (1997), 82,000 (1998), and 41,000 (1999) with most suckers age 0. The total entrainment estimates for A-Canal and the two Link River canals approach the total population estimate of age 0 suckers derived from lake sampling by Oregon State University (Simon and Markle 2001). The OSU age 0 sucker population estimates from August 1997 and 1998 were 82,000 and 665,000 respectively. The combined A-Canal and Link River entrainment indices for age 0 suckers in 1997 and 1998 were 64,000 and 328,000 with most suckers caught in August and September. Increases in entrainment are associated with apparent declines in the lake populations.

Entrainment has been a major factor contributing to the current endangered status of Lost River and shortnose suckers in the Klamath Basin. This impact has been most detrimental to larval and juvenile suckers. The entrainment associated with the Project have had a larger negative impact on sucker survival than non-Project entrainment.

6. Impacts of Water Quality

a. Upper Klamath Lake Watershed

Upper Klamath Lake is the primary water supply reservoir for the Project. It also supports the largest populations of endangered Lost River and shortnose suckers. However, in recent decades the lake has experienced serious water quality problems that have resulted in massive fish die-offs, as well as pronounced horizontal re-distribution of fish in response to changes in water quality. Previous investigations have shown that the lake has been productive for thousands of years (Sanville et al. 1974). This view of the lake as a naturally eutrophic system is consistent with its

shallow morphology, deep organic-rich sediments, and its large watershed with phosphorus-enriched soils. Watershed development, beginning in the late-1800s and accelerating through the 1900s is strongly implicated as the cause of the lake's current hypereutrophic character (Bortleson and Fretwell 1993). The poor water quality associated with massive algae blooms have led to major declines in Upper Klamath Lake sucker populations.

Recent sediment core studies indicated a substantial increase in sediment accumulation rates and nutrient concentration over the last 150 years corresponding with increases in erosional input from the watershed (Eilers et al. 2001). Sediment accumulation rates have increased from about 18 g/m²/year in 1880 to a high of 120 g/m²/year in 1995 (Table 4.5). The changes in sediment composition are consistent with land use activities that occurred during this period, including substantial deforestation, drainage of wetlands, and agricultural activities associated with livestock and irrigation. Blue-green algae (*Aphanizomenon flos-aquae*)--absent from the lake a century ago--showed major increases during the twentieth century and is now the dominant bloom-forming species.

Table 4.5 - Sediment accumulation rate from Upper Klamath Lake sediment core analysis (grams/m²/year; Eilers et al 2000).

Year	Sediment Accumulation Rate
1880	18
1900	20
1920	20
1940	30
1960	40
1980	60
1995	120

In the upstream basin, cattle have heavily grazed flood plains, wetlands, forest, rangelands, and riparian corridors, resulting in the degradation and the functional loss of these areas' contribution to minimizing sedimentation and accumulation rates. Livestock grazing has contributed to accelerated erosion and nutrient loading in the upper Klamath River basin, and especially to Upper Klamath Lake. Cattle grazing is associated with approximately 35% of the watershed above UKL. Cattle production in the area reached a peak near 1960 with a total of about 140,000 head (Table 4.6). Cattle production is currently near 100,000 head (Eilers et al. 2001).

Table 4.6 - Cattle production in Klamath County, Oregon derived from U.S. Department of Commerce (Eilers et al.)

YEAR	# CATTLE
1920	30,000
1930	40,000
1940	50,000
1950	60,000
1960	120,000
1970	80,000
1980	110,000
1990	100,000
2000	120,000

Throughout the Klamath River basin, timber harvesting and activities associated with it (such as road building) by federal, state, tribal and private landowners have resulted in soil erosion on harvested lands and transport of sediment into receiving waters adjacent to or downstream from those lands. Logging and road building practices in

the past did not often provide for adequate soil stabilization and erosion control. Approximately 80 percent of the upper basin is forested and intensive, even-aged timber harvesting methods (such as clear cutting) have been used. Timber harvest activities were most active from 1925 to 1945, reaching a maximum production in excess of 800 million board feet (mmbf) annually. Timber harvest production declined to about 200 mmbf in 1960 and has stabilized near 400 mmbf annually since 1970. Timber harvest in Klamath County, which represents about double the area of the Williamson River watershed, increased dramatically from about 120 mmbf in 1920 to 800 mmbf in 1940 (Table 4.7). Timber harvest and associated roads have contributed to the high sediment and nutrient inputs to Upper Klamath Lake from its tributary watersheds.

Table 4.7- Approximate annual timber harvest in Klamath County, Oregon in million board feet (mmbf) (Risley and Leanen 1999).

Year	Timber harvest (mmbf)
1920	120
1930	650
1940	800
1950	450
1960	200
1970	400
1980	400
1990	450

Increased phosphorus is a key factor in driving the massive blue-green algal blooms that now dominate nearly continuously from June through October. Although nitrogen is also important in structuring algal communities and determining biomass, phosphorus reduction has been shown to be the most effective long-term nutrient management option to control algal biomass. This is especially true for nitrogen fixing species such as *Aphanizomenon* that may be able to satisfy its nitrogen needs in what may otherwise be a nitrogen limiting situation. The chlorophyll-phosphorus relationships described by Kann (2000) also support phosphorus reduction as the management goal. In addition, in shallow hypereutrophic lakes, algal biomass in general and blue-green algae in particular show substantial reductions in response to reduction in total phosphorus loading, even when total phosphorus concentrations remain in the hypereutrophic range after restoration. The Oregon Department of Environmental Quality (ODEQ) has released water quality goals and plans for the Upper Klamath Lake Drainage, in a draft document entitled "The Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)". A 60-day comment period and formal hearing are scheduled for public input. The comment period will close on February 2, 2002. The operation and maintenance of the Wood River Ranch by the Bureau of Land Management include strategies to reduce phosphorus loading to Upper Klamath Lake.

High internal phosphorus loading is related in part to the high external loads entering the lake from tributaries and pumps that are deposited in the sediments. As previously noted, substantial increases in sediment accumulation rates, and nutrient concentrations in the sediments has occurred over the last 150 years attributed to land use practices in the watershed. Geiger (2001) suggests that isolation of wetlands is likely to have had the greatest effect on lake water quality and produced the accelerated lake eutrophication reflected in the sediment data of Eilers et al. (2001).

Despite high background phosphorus levels in Upper Klamath Basin tributaries, data exists from several studies to indicate that phosphorus loading and concentrations are elevated substantially above these background levels (Miller and Tash 1967; USACE 1982; Campbell et al. 1993; Kann and Walker 2000). Walker estimated that an increase in Agency lake inflow concentration from 81 to 144 ppb total phosphorus is the estimate of the anthropogenic impact. Kann and Walker (2000) estimated that approximately 40% of the phosphorus load can be attributed to man-caused sources.

Nutrient loading studies indicate that despite contributing only 3% of the water inflow (43,000 af/year), direct agricultural input from pumps around UKL accounted for 11% of the annual external total phosphorus budget (21

metric tons/year) and as much as 32% of the total during the peak pumping period of February through May (Kann and Walker 1999). The Sprague and Williamson rivers accounted for 51% of the average annual inflow (743,000 af/year) and 48% of the TP load (86 metric tons/year). Sevenmile Creek and Wood River contributed 9% and 19% respectively of the average total TP load. The disproportionate loadings from the smaller Sevenmile Creek and Wood River drainages illustrate the management importance of these areas. For example, TP unit area loads for the Wood River and Sevenmile Creek were 237 and 156 kg/km² respectively, which are an order of magnitude higher than those for the Williamson River watershed. Agricultural pumps around UKL were also very high (188 kg/km²). In addition, sediment regenerated P (internal loading) is also a large source of P in UKL, and P concentration from this source is directly related to lake level/volume and productivity characteristics.

Over 34,000 acres of wetlands (66% reduction) were isolated from UKL through diking and draining for non-project agricultural development. Approximately 15,000 acres of this total are in the process of being reclaimed to wetland but remain unconnected to UKL. The disassociation of the wetlands from the lake has meant a substantial loss of nitrogen and phosphorus uptake capacity (Geiger 2001). However, wetlands are both sinks and sources of nutrients depending on the time of year. During winter and spring wetlands are major sources of nitrogen and phosphorus because of wetland plant senescence and decomposition. Wetlands remove nutrients during the summer growing season. The timing of nutrient release and uptake is an important factor in the lake's water quality dynamics.

Wetlands also may affect water quality through production and release of decomposition products particularly dissolved humic substances that appear to inhibit *Aphanizomenon* growth. The absence or reduction of this algae just downstream, at or within marsh environments has been noted at Hanks Marsh (Forbes 1997) and Upper Klamath National Wildlife Refuge (Sartoris et al. 1993). Perdue et al. (1981) noted the absence of *Aphanizomenon* in UKL at a location heavily influenced by the Williamson River. Both wetlands in the lake, reclaimed wetlands behind the dikes, and winter flooded farm fields are potentially large reservoirs of what may be a valuable blue-green algae suppressant. The loss of in-lake wetlands, diffusing these humic compounds differently and at different times depending on hydrologic setting, would have resulted in lower lake concentrations of dissolved humic substances.

Internal phosphorus loading is another significant component of the nutrient budget affecting algal bloom dynamics and water quality in UKL (Barbiero and Kann 1994; Laenen and LeTourneau 1996; Kann 1998; Kann and Walker 2000). There is a large net internal loading occurring during late spring and early summer of each year. These large net internal loading events are generally followed by a substantial decline, indicating a large sedimentation event. Such events coincide with algal boom crashes (Kann 1998). On average, internal loading was 60%, while external loading was 40%. Although there is a high contribution of internal Total Phosphorus (TP) concentration during the algal growing season, it has been noted that the mobilization of phosphorus from iron has the potential to respond rapidly when primary productivity and pH maxima are reduced (Marsden 1989). The rapid response may be due to the reversal of the positive feedback mechanism associated with photosynthetically elevated pH. Elevated pH increases phosphorus release from the sediments to the water column by solubilizing iron-bound phosphorus in both bottom and re-suspended sediments as high pH causes increased competition between hydroxyl ions and phosphate ions decreasing the sorption of phosphate on iron. It appears that at a pH of about 9.3 the probability of internal loading sharply increases (Kann 1998). Empirical evidence from UKL indicates that as the bloom progresses and elevated pH increases the flux of phosphorus to the water column, increased water column phosphorus concentration further elevates algal biomass and pH, setting up a positive feedback loop.

Accelerated sediment and nutrient loading to Upper Klamath Lake have resulted in algae blooms of higher magnitude and longer duration. These blooms have led to extreme water quality conditions (high pH, low dissolved oxygen, and high ammonia) that increase fish stress, negatively impact fish health and increase the size and frequency of fish kills. Overall, sucker populations have declined largely due to this impact.

Oregon Department of Environmental Quality has identified nearly 25 stream segments flowing into UKL as being temperature limited (ODEQ 1998). Increased temperatures are symptomatic of degraded stream conditions resulting from loss of riparian vegetation and channel modifications associated with intensive grazing, flow reductions, and agricultural activities

b. Lost River Watershed

The Clear Lake watershed is mostly publicly owned by the U.S. Forest Service (Modoc National Forest) and the U.S. Fish and Wildlife Service (Clear Lake National Wildlife Refuge). Grazing is the primary land use. The condition of the watershed is good because of the management focus of the two agencies on water quality and habitat protection.

In the Gerber Reservoir watershed about 3/4 of the land is publicly owned by the U.S. Forest Service (Fremont National Forest) and Bureau of Land Management (Klamath Resource Area). Section 7 consultations on the effects of grazing management and forestry on suckers and bald eagles have been completed for the two federal agencies. The condition of the watershed is good because of the management focus of the agencies to protect water quality. A few creeks, e.g. Barnes Valley and Lapham creeks, are listed for exceeding temperature criteria (ODEQ 1998). The impaired temperature regimes are a symptom of degraded riparian and floodplain conditions generally resulting from overgrazing.

Most of the land ownership in the Lost River sub-basin below Clear Lake is private. Agriculture and grazing are the primary land uses. The condition of the watershed is good in the areas above Malone Reservoir and generally poor downstream to Tule Lake. Water quality is seasonally poor owing to nutrients and sediment input. Most of the Lost River is listed on the ODEQs 303(d) list for water-quality limited streams for the following criteria: chlorophyll-a, dissolved oxygen, temperature, and fecal coliform..

7. Impacts of Introduced Species

Introduced fishes including fathead minnows, yellow perch, and brown bullhead have become established in UKL. Fathead minnow populations exploded in the 1980s and became the most abundant fish in UKL. Concern about the potential impacts of the fathead minnow on sucker larvae prompted studies to assess the predatory capabilities (Klamath Tribes 1995). The studies indicated that fathead minnows were effective predators on sucker larvae, particularly in shallow water and in other areas where hiding cover was not available. When water depth increased to about 2 feet, the surface orientation of the sucker larvae and the bottom orientation of the fathead minnows result in enough separation nearly to eliminate predation. Competition and predation undoubtedly affect the current status of suckers in UKL by introduced fishes.

There is evidence that at least Lost River suckers may have a resident population in the Sprague River (L. Dunsmoor, Klamath Tribes per. com.). Introduced fish in that area include largemouth bass, yellow perch, pumpkinseed, brown trout, and brook trout that may compete with and/or prey on these fish.

Introduced fishes such as the brown bullhead, fathead minnow, Sacramento perch, pumpkinseed, green sunfish, bluegill, and largemouth bass have been accidentally or intentionally introduced into the Clear Lake and Gerber Reservoir watersheds (Buettner and Scoppettone 1991; Scoppettone et al. 1995; Reclamation 2000). Because relatively stable sucker populations co-exist with abundant non-native fish populations in Clear Lake and Gerber Reservoir, Reclamation does not consider exotic fish to be a major threat.

These same introduced fishes occur in the Lost River (Reclamation 2000; BRD 1999), Tule Lake (Scoppettone et al. 1995), and Klamath River (D and Markle 2000). In highly modified habitats like Lost River, Klamath River and Klamath River reservoirs, introduced fish appear to have a greater negative impact on endangered suckers (Dar and Markle 2001).). Many of the introduced fish species are more tolerant of habitat degradation and occupy a wider range of habitats than the suckers. The degraded habitats have resulted in less shoreline vegetation that provided suckers protection from predation by introduced fish.

8. Impacts of Fish Harvest

Historically, the Klamath Tribes on UKL, UKL tributaries, and the Lost River used Lost River and shortnose suckers for a subsistence fishery. From the 1960s until 1987, a snag fishery harvested spawning adult suckers mostly on the Sprague/Williamson and UKL springs. Over this period, the annual harvest of fish on the Sprague/Williamson declined 95 percent from about 12,500 to 680. In addition, several spawning groups at Barkley Springs, Harriman Springs, Odessa Springs, and other small springs along the East Side of UKL were extirpated.

On the Lost River, spring sucker runs were relied upon by not only Native Americans but also local settlers for both food consumption and livestock feed. A cannery was established and other commercial operations processed the suckers into oil, dried fish, and other products (USFWS 1994). The Klamath Tribes stopped subsistence harvest of suckers in 1987, and the snag fishery was closed about the same time.

Harvest of adult suckers was very detrimental to the Upper Klamath Lake sucker populations, which were already negatively affected by loss of spawning and rearing habitat and poor water quality. Several shoreline spawning groups likely were extirpated by removal of reproducing adults from the population.

9. Other Impacts

Other factors impacting the status of the species, including effects of urban land use and chemical contamination, have been addressed in previous consultations and are included here by reference (USFWS 2001).

4.2.2 IMPACTS ON SALMON

1. Impacts of Actions Affecting Salmon Habitat

Historic salmon habitat in the upper Klamath River basin was blocked as early as 1889 at Klamathon (near Iron Gate). Beginning in 1910, the Federal Bureau of Fisheries installed a fish rack to capture salmon eggs, leaving little chance for passage of upstream migrants after that time. In 1917, the construction of Copco Dam formed a complete block to upstream migration and the loss of over 75 miles of habitat in the Klamath River plus tributaries as far upstream as above Upper Klamath Lake.

Mining activities within the Klamath Basin began before 1900. Water was diverted and pumped for use in sluicing and hydraulic mining operations. This resulted in dramatic increases in silt levels altering stream morphology and degrading spawning and rearing areas. The mining activities may have had a greater negative impact to the salmon fishery than the large fish canneries of the era. Since the 1970s, mining operations have been curtailed due to stricter environmental regulations. However, mining operations in some of the Klamath River tributaries continue including suction dredging, placer mining, gravel mining, and lode mining. These operations can adversely affect spawning gravels, decrease survival of eggs and juvenile fish, decrease the abundance of bottom food organisms, adversely affect water quality, and impact stream banks and channels.

Roads associated with timber harvesting and timber management activities have contributed to erosion and increases in sedimentation in streams causing degradation of spawning gravels, pool filling, reduced aquatic insect abundance, and changes in channel structure and habitat diversity.

2. Impacts of Water Diversions and Diversion Structures

a. Klamath River Mainstem

Beginning in late 1800s, construction and operation of the numerous Project and non-Project facilities have changed the natural hydrographs of the mainstem Klamath River. Project facilities include the A-Canal and Lost River Diversion Dam. Non-Project facilities include Copco Nos. 1 and 2 Dams, J.C. Boyle Hydroelectric Dam, Iron Gate Dam (IGD), and Keno Dam. Changes in the flow regime at Keno, Oregon, after the construction of the A-Canal, Link River Dam, and the Lost River Diversion Dam, can be seen in the 1930-to-present flow records. These changes have reduced average flows in summer months and altered the natural seasonal variation of flows to meet peak power and diversion demands (Hecht and Kamman 1996). Flows downstream from Iron Gate Dam affect the quantity and quality of aquatic habitat for coho salmon in the mainstem Klamath River in California.

Iron Gate Dam, located approximately at River Mile 190 on the mainstem Klamath River, was completed in 1962 and is owned and operated by PacifiCorp. Iron Gate Dam was constructed to re-regulate flow releases from the Copco facilities, but it did not restore the pre-project hydrograph. Minimum stream flows and ramping rate regimes

were established in the FERC license covering operation of Iron Gate Dam. A fish hatchery was constructed by PacifiCorp as a mitigation measure for the loss of fish habitat between Iron Gate and Copco No. 2 Dams.

The effects of flow regimes resulting from Project and non-Project activities above Iron Gate Dam are discussed in detail in the 2001 BA and 2001 BO.

b. Klamath River Tributaries

Table 4.8 displays the irrigated lands and water applied to these lands in the Shasta and Scott River valleys downstream from the Project. Development of these irrigated lands, and associated flow diversions from the Shasta and Scott Rivers, affect the aquatic habitat for coho salmon.

Table 4.8 - Annual irrigated lands (acres) and applied water (acre-feet) for Shasta and Scott River Valleys (C. Ferchaud personal communication).						
	Irrigated lands			Applied water		
Year	Shasta	Scott	TOTAL	Shasta	Scott	TOTAL
1970	48,000	31,500	79,500	130,300	92,400	222,700
1980	45,800	33,500	79,300	146,100	98,700	244,800
1985	46,500	33,600	80,100	144,000	97,600	241,600
1988	50,000	34,100	84,100	150,500	96,400	246,900

i. Upstream migration of spawning adults

Stream flow in certain reaches of the Scott and Shasta Rivers during the early fall is a limiting factor for the spawning migration of adults of each species. Flow in these tributaries is strongly affected by diversions. Irrigation demand lessens near the end of September after the final cutting of alfalfa, but some diversions continue during the fall, primarily for stock watering. In the Little Shasta River, agricultural diversions of virtually the entire stream are legally made from October through mid-April. These diversions fill several small storage reservoirs (R. Dotson, CDFG, personal communication). Lack of water creates low velocities and depths in the stream, which can hinder or completely block movement by the large spawning adults, particularly the fall-run chinook salmon. This problem has long been noted in the Scott and Shasta Rivers (CDFG 1965). As a result, the timing of the historically early runs is delayed until irrigation diversions stop, and the river level rises to an adequate level (West 1983).

During dry years, the diversion of even 10 to 15 cfs for stock watering can be critical to migration access when the Scott River is only running at 35 cfs in mid-October, as it was in 1988 (USGS 1989). In the Shasta River, fall chinook have access to only the lower 10 to 15 miles in dry years, but to over 38 miles in wet years (CH2MHill 1985). Another effect on adult migration is the physical barrier of temporary diversion dams. These dams have long been the subject of concerns by CDFG biologists and wardens (CDFG 1965, CDFG 1980a). The temporary dams that are suppose to be removed after the irrigation season, have not always been removed in time to allow upstream migration of spawning salmon to suitable spawning habitat. This results in less spawning and lower numbers of juveniles.

Recently, many of the dams were replaced by wells adjacent to the stream in the mainstem Scott River. Other streams still have problems. On Horse Creek, a 12-foot high diversion dam continues to block all spawners to 14 miles of upstream habitat (S. Fox, USFS, personal communication). California Department of Fish and Game has recommended a flow of 150 to 200 cfs for adult chinook salmon to "navigate the Scott River safely and reach the best spawning grounds," an amount which has rarely been met in October (see discussion below) (CDFG 1980, USGS 1989). The CFGD currently recommends 150 to 200 cfs in the Scott River for adult chinook salmon during October. Presently, flows in Shasta River during October are typically about 35 cfs in most years. Flows during October are especially critical to upstream migration of spawning adult chinook salmon in the Scott River

ii. Downstream migration of juveniles

Steelhead young and surviving adults, as well as coho salmon young, are very vulnerable to stream diversions in the spring and summer months. If irrigation begins in March in dry years, then fall chinook juveniles may also be affected. Smolts are trying to migrate downstream to the ocean during the same period as the irrigation season, from April to August. Adequate flows and clear passage are needed but are not always found. Downstream migrants trapped in pools or side channels when stream flows drop sharply during early summer soon die from high temperatures, lack of food, or predation. Some portions of streams often become entirely dewatered due to diversion: lower Shackleford Creek, lower French Creek, lower Etna Creek, Kidder Creek, McAdams Creek, Moffett Creek, and Scott River below Farmers' Ditch (CDFG 1965, Puckett 1982). In 1989, a near normal water year, fish rescue efforts by CDFG captured 341,428 juvenile steelhead below diversions in these dewatered streams of the Scott River system during the months of May through July (R. Dotson, CDFG, personal communication).

c. Shasta River Valley

Tributaries to the Klamath River are very important to coho salmon. While none of the following activities are project-related, but are very important to the current status of coho salmon. Water development began with the arrival of the gold miners in the late 1800s. After the gold rush, non-Project agricultural development resulted in additional and more extensive use of water from the Shasta River. Dwinell Dam was completed by non-Project water users in 1928 on the Shasta River and formed Lake Shastina. The dam impounds winter and early spring run-off for irrigation water. The dam effectively blocked salmon access to about 22 percent of the total spawning habitat formerly available to salmon and steelhead and about 17 percent of drainage area.

The amount of lands under irrigation mushroomed from 57,000 acres in Siskiyou County in 1912 to nearly 100,000 acres in 1914 (French 1915). Dry farming practices continue by farmers for certain crops in both valleys. The Shasta River sub-basin consists of approximately 507,000 acres (CDFG 1997). About 28 percent of this acreage is irrigable and exists primarily downstream from Dwinell Dam. The climate of the Shasta Valley is characterized by warm, dry summers and cool wet winters. Precipitation averages 12 to 18 inches annually with 75 to 80 percent of it occurring between October and March (CDFG 1997). The average length of the growing season is about 180 days.

Over 80 years ago, between Montague and Grenada in the Shasta Valley, the Montague Land and Irrigation Company pumped water into its ditches through two centrifugal pumps lifting 16,840 gallons per minute to ditch heads 86 and 107 feet above, to be released onto 5,000 acres of adjacent lands in 1915. Water from a dozen wells near Big Springs irrigated another 10,000 acres (French 1915). By 1931, a biologist was already commenting on the decline of the Shasta River's contribution to the Klamath River's salmon population, attributing its condition to "local causes such as diversion of water for agriculture, mining, and power purposes, spearing fish on the spawning beds, and what not" (Snyder 1931).

By the 1960s, the California Department of Fish and Game (CDFG) noted that diversion dams blocked fish migration passage over numerous diversion dams in the Shasta River, and in 1974, CDFG noted that agricultural activities and fishery values were largely incompatible (NMFS 2001). While natural low water conditions can be unfavorable to salmonids, fish passage blockage is exacerbated by numerous water diversions. Seven major diversion dams and several smaller dams or weirs operated by private non-Project water users exist on the Shasta River below Dwinell Dam (CDFG 1997). Numerous diversions and associated dams exist on other major tributaries to the Shasta River, including Big Springs Creek, Little Shasta River and Parks Creek. When all these diversions are operating, flows are substantially reduced in the summer and fall. In Little Shasta River, stream flows cease entirely in the lower several miles of the stream during the summer and fall period.

Currently, irrigation of permanent pasture and alfalfa fields below the ditches or near the river is primarily done by "wild flooding," by private, non-Project water users with much of the return water recaptured and used on lower pasture lands (CDWR 1989). The Montague Water Conservation District provides water to about 11,000 acres of the 48,000 acres of irrigated farmland in the valley from Lake Shastina (50,000 acre-feet storage), located on the upper Shasta River (NCRWQCB 1989). The topography of the Shasta Valley is quite uneven with many small hills and shallow, volcanic soils, creating challenges in farmland irrigation practices.

Table 4.9 - Annual water demand (applied water) by agriculture in the Shasta River Valley (estimated by the California Department of Water resources (C. Ferchaud personal communications)

Year	Applied Water (acre-feet)	Irrigated acres
1970	130,300	48,000
1980	146,100	45,800
1985	144,000	46,500
1988	150,500	50,000

Table 4.10 summarizes water rights of four water service agencies formed in the Shasta Valley before the construction of Dwinell Dam (CDFG 1997). The Shasta River Water Association (SRWA) serves the west side of the Shasta Valley near the town of Montague. The Grenada Irrigation District (GID) serves about 1,800 acres located west of the town of Grenada. The Big Springs Irrigation District (BSID) serves about 3,600 acres north of Big Springs Lake. Since the late 1980s, BSID has used ground water in lieu of water diverted from Big Springs Lake. The Montague Water Conservation District (MWCD) has rights for winter storage of Shasta River and Parks Creek in Lake Shastina to meet irrigation needs in the Little Shasta Valley and the northeast portion of the Shasta Valley from April 1 to October 1. The only storage releases from Dwinell Dam, except during above normal water years, are those to satisfy the needs of several small users immediately downstream of the dam.

Table 4.10 - Water rights for water service agencies in Shasta River Valley (April 1 - October 1)

Water Agency	Year Formed	Water Right
Shasta River Water Association (SWRA)	1912	42 cfs
Grenada Irrigation District (GID)	1921	40 cfs
Big Springs Irrigation District (BSID)	1927	30 cfs from Big Springs Lake
Montague Water Conservation District (MWCD)	1925	Winter storage in Lake Shastina

Dwinell Dam (built by non-project water users) and increased water diversions for agricultural, stock water, recreational and domestic uses have resulted in changes to the annual flow regime of the Shasta River affecting migration and spawning of coho salmon. In general, higher base flows existed in the river before the construction of Dwinell Dam than currently exist for the spring summer, and early fall periods. Before Dwinell Dam, mean daily flows in the Shasta River during the spring (April through June) were 132 cfs (CDFG 1997). During the years 1985 through 1994, flows during the spring averaged 87 cfs; a 34 percent reduction during the coho salmon smolt out-migration period. Average summer flows (July and August) for pre and post-dam conditions are 42 cfs and 28 cfs, respectively. Mean daily flows for September for pre and post-dam conditions are 79 and 61 cfs, respectively.

In addition to blocking access to spawning and rearing habitats for anadromous salmonids, Dwinell Dam also prevents replenishment of new spawning gravel to the river downstream of the dam (CDFG 1997). Water held in Lake Shastina each winter reduces the frequency and magnitude of runoff events in the Shasta River below the dam, allowing fine sediment to accumulate on existing spawning gravel. Excessive amounts of fine sediments resulting from increased bank or upslope erosion settle in the spawning gravel, thereby armoring the substrate and creating survival problems for eggs deposited by coho salmon. In addition, emerging fry can become trapped in the gravel by sedimentation and may be unable to escape the stream substrate.

Under current conditions, Shasta River flow reductions caused by irrigation diversions are more dramatic than the gradual flow declines observed during pre-dam years. During the drought year of 1992, flows dropped from 105 cfs on March 31 to 21 cfs on April 5 due to the start of the irrigation season (CDFG 1997). Documented fish kills resulted.

Shasta River flows affect the distribution of spawning in the Shasta sub-basin (CDFG 1997). Low flows limit the ability of fish to access and utilize the Shasta River above Louie Road. Skinner (1959) noted that flows between Dwinell Dam and Louie Road (Big Springs) were inadequate in providing suitable spawning habitat. A check of the Shasta River between Parks Creek (RM 32) and the Hole in the Ground Ranch (RM 34) in 1994 revealed that no salmon utilized this area despite an apparent abundance of gravel (CDFG 1997). During the 1995 and 1996 seasons, flows were higher than previous years and numerous redds were counted in this same area and January 16, 2002 in the lower half-mile of Parks Creek.

d. Scott River Valley

The Scott Valley has a long history of stream diversions. A June 1934 stream survey of the Scott River by the CDFG noted that the ditch beginning at the concrete diversion dam near Etna (now known as Young's Dam) was diverting about 30 cfs, while only two to five cfs was passing through the planks in the upper half of the dam into the main river. Salmonid fry were observed beyond the fish screen at that time (CDFG 1934). On June 9, 1934, no surface water from Shackleford Creek was reaching the Scott River, "all of it being taken into irrigation ditches" (Taft and Shapovalov 1935).

In 1958, water use in the Scott Valley was estimated at 118,200 acre-feet which was applied to 31,300 acres through 240 miles of ditch and pipeline by about 200 diversions (CDWR 1963). Although the 1958 water year was the wettest season on record at the time, water in the Scott River was still insufficient to meet all of the late season irrigation demand (McCreary Koretsky 1967). Considerable acreage was also sub-irrigated or dry farmed. Water use averages about 3.0 acre-feet per acre year.

Table 4.11 - Estimated agricultural water demand (applied water) in the Scott River Valley (C. Ferchaud, California Dept. of Water Resources, personal communication)

Year	Applied Water	Irrigated acres
1970	92,400 acre -feet	31,500
1980	98,700 acre -feet	33,500
1985	97,600 acre -feet	33,600
1988	96,400 acre -feet	34,100

CDFG concluded in 1974 that, "many of the methods and extent of diversion and irrigation currently in practice in the Scott River Basin have created a large degree of incompatibility between agriculture and fisheries. The flows required to maintain fishery values and support heavy agricultural diversions clearly are not in the system during the latter part of July, August, and often in September. Many of the streams would have critical level flows (less than minimum) during this time period even if no water is diverted."

Sections of stream systems noted as being dry or intermittent during the summer months are (CDFG 1974):

- ? Scott River at river mile 50 for one to three miles below diversion ditch.
- ? East Fork Scott River below diversion dams.
- ? Etna, Kidder, and Patterson Creeks over several miles of lower reaches.
- ? Sniktaw and Shackleford Creeks near their mouths.
- ? Patterson Creek (near Meamber Bridge) and Indian Creek.
- ? Moffett Creek.

Presently, low flows in the Scott River are a major constraint to access to fall Chinook spawning areas in drought years (Kier and Associates 1999). In 1994, fall chinook were able to spawn only in the lowest six reaches of the Scott River (approximately 25 miles). In years with high flows, such as 1995, fall chinook can move more than 60 miles upstream through the Scott Valley.

Reaches of the Scott River in the lower Scott River Valley at Highway 3 may go dry in drought years. During a sequence of drought years from 1987 to 1992, tributaries such as Kidder Creek were dry even during winter months (Kier and Associates 1999). Shackleford Creek continues to dry up before joining the Scott River during late

summer because of irrigation diversions. Long-term trends show that periods of critically low flow have tended to increase since 1942 when flow records began to be monitored consistently on the Scott River. There appears to be a substantial increase in the number of days with extremely low flows (< 40 cfs). Moffett Creek lost perennial surface flow in the late 1950s because of ground water depletion. The drop in ground water levels has contributed to loss of riparian vegetation, which in turn affects bank stability.

The U.S. Forest Service has riparian rights downstream of the valley on Scott River (Kier and Associates 1991) as shown in Table 4.12:

Table 4.12 - U.S. Forest Service Scott River riparian rights downstream from Scott River Valley	
Period	Riparian Right (cfs)
November-March	200
April - June 15	150
June 16 - June 30	100
July 1 - July 15	60
July 16 - July 31	40
August - September	30
October	40

Kier and Associates (1991) compared actual flows in the Scott River for water years 1986 to 1989 to the above flows. Assuming the flows are minimums for the period, the above flows were not met in the following months of the years (Project water year type definition is in the third column):

1986	Oct, Nov, Dec	Above Average
1987	Oct, Nov, Dec, Jun, Jul, Aug, Sep	Below Average
1988	Oct, Nov, Dec, Jul, Aug, Sep	Dry
1989	Oct, Jul, Aug, Sep	Above Average

e. Other Areas

Besides the above two major valleys, smaller water diversions for agriculture occur in several other direct tributaries to the middle Klamath River: Grider Creek, Cottonwood Creek, Horse Creek, Bogus Creek, Little Bogus Creek, and Willow Creek.

Direct diversion of water from streams into ditches by placer miners began in the 1850's (Wells 1881). Mining diversions, both current and abandoned, on the Scott and Salmon Rivers were recognized during stream surveys in the 1930's as a fish problem due to lack of screens. Biologists at that time did not consider water diversions much of a problem because the larger mining diversions operated during the winter and most of the flow returned directly to the river (Taft and Shapovalov 1935). In the 1950's, the California Department of Fish and Game (CDFG) removed abandoned diversion dams throughout the streams of the basin, but many of the ditches remain in place (CDFG 1965). Some of the old mining ditches were later used for irrigation.

3. Impacts of Barriers to Upstream Migration

Fish ladders have been placed at permanent stream structures in the Scott River. In 1990, a ladder was built over the City of Etna's diversion dam on Etna Creek. Similar structures were also placed over Young's Dam on the Scott River and over a barrier in Thompkins Creek. Their effectiveness needs to be evaluated and any necessary improvements made.

Scott River fish passage problems are due to low flows in the valley around Fort Jones blocking access for adults to 35 miles of upstream habitat. The irrigation season is established from about April 1 to about October 15 of each

year (Scott River adjudication). Diversion structures must be constructed to allow any water in excess of the specific diversion allotment to pass to the stream channel to allow passage of fish during irrigation season, but prior to about June 1. Gravel diversion dams must be breached at the end of the irrigation season to allow adult fish to ascend to spawning grounds (there is no general limitation for consideration of fisheries during the period between June 1 and October 15). Domestic and stock watering users are entitled to .01 cfs at place of use during the non-irrigation season. An inventory of diversion dams and fish passage in the Scott River watershed is lacking. The Scott River and its tributaries are not navigable streams. As a result, original riparian land patents included title to the bed and banks of streams within the system, as well as the private right of fishery.

Wales (1951) estimated that Dwinnell Dam on the Shasta River, constructed in 1928, eliminated access to about 22 percent of the total spawning habitat formerly available to salmon and steelhead, and approximately 17 percent of the drainage area. Seven major diversion dams and several smaller dams or weirs now exist on the Shasta River below Dwinnell Dam. Numerous diversions and associated dams exist on other major tributaries as well, including Big Springs Creek, Little Shasta River and Parks Creek. A pump on Shasta River, which facilitates fish passage, has replaced one diversion dam. The Shasta River and its tributaries are not navigable streams. Hence, original riparian land patents included private title to the bed and banks of streams within the system, as well as the private right of fishery. A culvert on lower Mynot Creek has blocked fish passage for salmon and steelhead to two miles of habitat since it was installed. Arcata Fish and Wildlife Service funded the California Conservation Corps for replacement/removal of the culvert.

4. Impacts of Unscreened Diversions

Many salmon, steelhead juveniles, and some adults enter unscreened agricultural diversions each year and are lost. A fish screen installation program for the Scott River began in 1938 but has not yet been completed. Since the Scott River adjudication in 1980, river pumps have been replaced with wells and only a few remaining pumps are still entraining fish. A recent preliminary inventory of diversion ditches possibly affecting anadromous fish indicates an estimated 125 unscreened ditches (Sommarstrom, 1994). Field checking of these diversions is still needed and most will likely require screening. California law requires CDFG to screen and maintain diversions less than 250 cfs installed before 1972 (Fish & Game Code Sections 6020 et seq.). All diversions in the Scott River Valley are smaller than this size and most were developed before 1972. To date, CDFG has screened 30 diversions throughout the Scott River (R. Dotson, CDFG, pers. comm.). Present budgetary and staffing constraints limit the CDFG's Yreka Screen Shop to build only two new fish screens each year. In addition, daily and yearly maintenance practices are difficult to sustain by the Department, especially as more screens are added. Fish screening efforts have been expedited through supplemental state grants to Etna High School for student-built screens (one or two screens per year), private grants for local-built screens (one or two per year), and new federal cost-share funds (ASCS, now CFSA) to landowners. Old screens may also need replacing, and alternative screening technologies to prevent fish losses could be pursued (Odenweller, 1994). In addition, current screening practices need evaluation to determine if they are adequately protecting the fishery resources at screened diversion sites (i.e., are significant numbers of juvenile/adult fish being lost when screens are removed in the fall/winter.)

There are numerous agricultural diversions in the Shasta River and major tributaries including Big Springs Creek, Little Shasta River, and Parks Creek. Many of these diversions are unscreened or inadequately screened resulting in loss of juvenile salmon.

5. Impacts of Water Quality

In addition to hydrologic changes caused by the activities discussed above, human activities have resulted in degraded water quality in the Klamath River basin. The Klamath River, from source to mouth, is listed as water quality impaired (by both Oregon and California) under Section 303(d) of the Federal Clean Water Act (CWA). In 1992, the State Water Resources Control Board (SWRCB) proposed that the Klamath River be listed under the CWA as impaired for both temperature and nutrients, requiring the development of Total Maximum Daily Load (TMDL) limits and implementation plans. The United States Environmental Protection Agency (USEPA) and the North Coast Regional Water Quality Control Board (NCRWQCB) accepted this action in 1993. The basis for listing the Klamath River as impaired was aquatic habitat degradation due to excessively warm summer water temperatures and algae blooms associated with high nutrient loads, water impoundments, and agricultural water diversions.

(USEPA 1993). However, the Klamath River has probably always been a relatively warm river (Hecht and Kamman 1996).

Tributary influences to the Klamath River mainstem temperatures are seasonally important (Deas and Orlob 1999). During the spring, certain tributaries contribute significant inflow to the mainstem. For example, Scott River flows are appreciable and cool, derived from snowmelt runoff in the Marble Mountains, and have a notable impact on the Klamath River downstream of the confluence. Conversely, the Shasta River is regulated by Dwinnell Reservoir, is heavily utilized for agriculture, and experiences a smaller, more moderate snowmelt runoff hydrograph than the Scott River (Deas and Orlob 1999). By mid- to late spring, the river base flow drops in response to irrigation demand, and tributary contributions to the mainstem are minor. In the summer and early fall, tributary flows are small relative to the mainstem flow. Locally, these tributaries may have an impact, but generally, they provide minor contribution to the water temperature of the system (Deas and Orlob 1999). The termination of irrigation in late fall results in increased inflow from the Shasta and Scott Rivers. These tributaries have small thermal mass compared to the Klamath River (and Iron Gate Reservoir), and thus can cool quickly to provide local thermal relief to the mainstem. Deas and Orlob (1999) discussed one day, October 10, 1999, when the Shasta River reduced mainstem temperature by approximately 1 E C (1.8 E F), while the impact of the Scott River was smaller because it is 30 miles downstream from the Shasta River and the mainstem cooled appreciably in the interim.

Stream temperatures above tolerable levels for salmonids are attributed for over 20 years to low flow conditions and the return of warmed irrigation return water to the Scott and Shasta Rivers (CDFG 1965, CSWRCB 1974, CDFG 1980a, CH2M-Hill 1985). Cooler water (about 56° F) is needed for chinook salmon spawning in the fall. As shown in Figure 2-22, temperatures below 59° F are considered optimum for rearing anadromous salmonids while lethal temperatures occur at about 78-80°F, depending on the adaptability of the local stock. Cooler water pockets are found in the bottom of deep pools, but sedimentation will fill in pools. In the Shasta River, monitoring efforts recorded a high of 85°F in July 1982 near its mouth and 78°F at the mouth of the Scott River (CDWR 1986). Such high temperatures continue to be an annual problem (D.Maria, CDFG, personal communication).

Oxygen levels in portions of the Shasta River have reached critically low levels for salmonids in recent years (e.g. 4.7 ppm in 8/81) (CDWR 1986). A minimum level of 7.0 mg/l (ppm) is the specific water quality objective for the Shasta and Scott Rivers of the North Coast Regional Water Quality Control Plan, which was designed to protect the anadromous fish populations (NCRWQCB 1989). Overall, the impacts of low flows and high temperatures have created poor to fair conditions for salmon and steelhead, as summarized below in Table 4.13 (CDFG 1974).

Table 4.13 Adequacy of current stream flow and temperature conditions for anadromous salmonid populations in the Scott River (CDFG 1974)

Species and run	Holdover of adults prior to spawning	Spawning	Juvenile rearing
Steelhead (winter-run)	Good	Good	Poor
Chinook salmon:			
Spring-run	Poor	Poor	Fair
Fall-run	Poor to fair	Poor to fair	Fair
Coho salmon	Fair	Fair	Fair

After Dwinnell Dam was constructed, nutrient-rich Lake Shastina experienced elevated water temperatures, increased algae growth, and decreased dissolved oxygen levels (NMFS 2001). Nutrient sources into the lake include agricultural, urban, and suburban land use. The dam also prevented spawning gravel recruitment into the downstream river reach. Water temperature has been recognized as a problem in the Shasta River since at least 1961, with temperatures reaching as high as 85° F between 1961 and 1970 (CDFG 1997). High river temperatures exceeding 80 °F, primarily during June, July, and August, continue to occur in the lower Shasta River.

Extensive water quality monitoring in the Shasta River between 1985 and 1995 revealed river conditions during this time that often exceeded numeric and narrative criteria contained in the State's North Coast Regional Water Quality Control Board (NCRWQCB) Basin Plan (Plan) for the protection of salmon and steelhead (CDFG 1997). Dissolved oxygen levels less than 5.0 mg/L have been recorded in the Shasta River in recent years, primarily in the morning hours (Plan objective is 7.0 mg/L). Of the 296 dissolved oxygen measurements recorded from July 1986 through June 1992, 15.2 percent were less than 7 mg/L and 3.4 percent were under 5 mg/L, indicating serious dissolved oxygen problems.

Water quality problems are associated with many of the smaller diversion structures on the Shasta River below Dwinell Dam (CDFG 1997). These structures serve as temperature and nutrient traps leading to conditions favorable for aquatic plant growth, areas of increased organic decay and elevated aerobic bacteria activity. This creates localized dissolved oxygen and thermal problems, which can kill coho salmon trapped behind the diversion structures. The extensive water use and associated tail water return may be exacerbating high stream temperatures and nutrient loading during the late spring and early summer months.

The Shasta and Scott Rivers, tributaries of the Klamath River, historically supported healthy populations of chinook salmon, coho salmon, and summer-run steelhead (KRBFTF 1991). Development of irrigated agriculture in the lower Klamath River basin was an asset to this area's economy. However, water diversions adversely affected another valuable asset, the salmon and steelhead fishery. Removal of water from streams has a critical relationship to the timing of different life stage needs of anadromous fish. While natural-occurring low water conditions can be unfavorable to salmonid fish, this condition is greatly aggravated by numerous non-Project agricultural diversions.

6. Incubation and rearing habitat for juveniles

Steelhead eggs are still incubating in the gravels during May, June, and early July, depending on the timing of spawning and the water temperatures. Since developing eggs are very dependent on an adequate exchange of fresh water to provide oxygen and to remove metabolic wastes, inadequate flows can reduce egg survival (CDFG 1980). Fall chinook eggs and young are probably the least vulnerable to diversions, while steelhead and coho salmon juveniles are very susceptible because they need to spend at least one full summer in the stream. Rearing habitat requires sufficient shelter, food, and water temperature. Reduced flows shrink the amount of shelter in pools (see Figure 2-21) as well as the quantity of streambed invertebrates available for food from the riffle areas. Lack of shelter also exposes the fish more to potential predators, such as heron and otter. All of these factors lower the number of fish the river can support (CDFG 1980). The large numbers of young steelhead and coho rescued by CDFG from drying tributaries and the main rivers (over 300,000 per year from the Scott Basin alone) indicates the significant loss of population occurring from this deprivation of habitat (Puckett 1982).

7. Impacts of Fish Harvest

Commercial fishing for salmon in the Klamath River had major impacts on populations as early as 1900. Commercial and recreational ocean troll fisheries, tribal subsistence fisheries, and in-river recreational fisheries have impacted salmon including coho throughout the 20th Century. Over-fishing was considered one of the greatest threats facing the Klamath River coho salmon populations in the past. However, these harvest rates probably would not have been as serious if spawning and rearing habitat was not so extensively reduced and degraded. Sport and commercial fishing restrictions ranging from severe curtailment to complete closure in recent years may be providing an increase in adult coho survival. The tribal harvest in the Klamath has been relatively small in the last five years and likely has not had a measurable effect on coho populations.

8. Impacts of Hatchery Programs

The Klamath and Trinity Basin Coho salmon runs are now composed largely of hatchery fish, although there may still be wild fish remaining in some tributaries. Because of the predominance of hatchery stocks in the Klamath River Basin, stock transfers (use of spawn from coho outside the Klamath River Basin) in the Trinity and Iron Gate Hatcheries may have had a substantial impact on natural populations in the basin. Artificial propagation can substantially affect the genetic integrity of natural salmon populations in several ways. First, stock transfers that result in interbreeding of hatchery and natural fish can lead to loss of fitness (survivability) in local populations and loss of diversity among populations. Second, the hatchery salmon may change the mortality profile of the

populations, leading to genetic change relative to wild populations that is not beneficial to the naturally reproducing fish. Third, hatchery fish may interfere with natural spawning and production by competing with natural fish for territory or mates. The presence of large numbers of hatchery juveniles or adults may also alter the selective regime faced by natural fish.

4.3 ANTICIPATED IMPACTS OF ALL PROPOSED FEDERAL ACTIONS IN THE ACTION AREA THAT HAVE ALREADY UNDERGONE EARLY OR FORMAL SECTION 7 CONSULTATION

All proposed Federal projects in the action area that have already undergone consultation are also included in the baseline. No major proposed Federal projects in the action area have been included for purposes of the environmental baseline in this BA.

Unrelated Federal actions affecting the same species or critical habitat that have completed formal or informal consultation are also part of the environmental baseline, as are Federal and other actions within the action area that may benefit listed species or critical habitat. In addition, for this consultation only, Reclamation has included in the environmental baseline depletion-related effects resulting from discretionary actions by other federal agencies that may not yet have been the subject of consultation. As Reclamation gathers more information about the status of these consultations, it may be appropriate to exclude any such effects from the environmental baseline in any future BA.

4.3.1. Operation of PacifiCorp's Klamath Hydroelectric Project FERC No. 2082

PacifiCorp operates its hydroelectric facilities at the Westside and Eastside power plants at Link River Dam, Keno Dam, J. C. Boyle Dam, Copco No. 1 and Copco No. 2, and Iron Gate Dam as described in the 1996 BA (Reclamation 1996a). These facilities are operating pursuant to a license issued by the Federal Energy Regulatory Commission (FERC) that expires in 2006 and a biological opinion dated July 15, 1996 (USFWS 1996). PacifiCorp's operations are covered under the 1996 BO and are only included in the environmental baseline in this BA.

4.3.2. Operation of New Earth /Cell Tech Facilities

New Earth operates and maintains an algae harvesting and processing facility at the head end of the C-Canal under permit from Reclamation. A detailed description of these privately owned facilities is provided in the 1996 BA (Reclamation 1996a) and BO (USFWS 1996). New Earth's operations are only included in the environmental baseline in this BA.

4.4 IMPACT OF STATE OR PRIVATE ACTIONS THAT ARE CONTEMPORANEOUS WITH THE CONSULTATION

State or private actions that are contemporaneous with this consultation are also included in the environmental baseline. For purposes of this BA only, the effects of contemporaneous private actions of upstream depletions associated with water rights that may be junior or senior to those of the Project are included in the environmental baseline. All upstream depletions are occurring and have affected Upper Klamath Lake elevations, thus affecting the current status of listed species. Reclamation reserves the right to exclude such effects from any future BA.

4.4.1 Beneficial State or Private Actions

In addition to the state and private actions discussed above, the following state or private action are occurring contemporaneous with the consultation:

- * The Nature Conservancy acquired approximately 8,000 acres of former wetlands around UKL (Tulana Farms and Goose Bay Farms) in the last five years. They have initiated wetland wetland

restoration projects on these properties. These projects are located adjacent to the Williamson River Delta.

- * The Running Y Ranch Resort has initiated a wetland restoration projects on former Caledonia Marsh adjacent to UKL (up to 500 acres).
- * Fish screening and fish passage projects on the Sprague River by private landowners.
- * Sycan Marsh Preserve wetland restoration on the Sprague River by The Nature Conservancy.

4.5 CURRENT BASELINE CONDITION WITHOUT THE PROPOSED ACTION

4.5.1 Baseline Condition of Lost River and Shortnose Suckers

1. Adult Sucker Data

There have been a couple attempts to estimate the size and age structure of sucker populations in UKL (Bienz and Ziller 1987; USFWS 2001). However, confidence intervals are large, methodologies differ, and interpretation of these numbers should be cautious. At an order-of-magnitude scale, all of the estimates suggest adult populations between 1984 and 1997 are measured in the low thousands to low 100 thousands. Since 1997, no population estimates have been made but adult populations are probably at least in the low tens of thousands based on the numbers of fish captured in spawning run monitoring and relatively low tag recapture rates (M. Buettner, Reclamation per. com.). Because there are no reliable long-term adult population estimate data, abundance indices have been relied upon. For example, a Williamson River spawning abundance index was downward from 1995 to 1998 (Shively et al. 2001) consistent with three consecutive adult sucker kills during 1995, 1996, and 1997. In 2000 and 2001 abundance indices were higher than those in 1998 and 1999 but were lower than those in 1995 and 1996 (R. Shively, BRD, per. com.).

In the 1980's at the time of listing, the sucker populations in Upper Klamath Lake appeared limited by lack of juvenile recruitment and were heavily skewed to older fish, 18-28 years (Buettner and Scopettone 1990). In the late 1990s, successful recruitment from 1991 and 1993 year classes brought in some younger fish (Cunningham and Shively 2000; USFWS 2001), but many older fish appear to have died prematurely, probably because of the fish kills in 1995, 1996, and 1997. Based on lengths of suckers entering the Williamson River in 2000 and 2001 (Cunningham and Shively 2001; Shively per. com. 2002) and age frequency information from the fish kills, most adult Lost River and shortnose suckers are from the 1991 and 1993 year classes. Coupled with the apparent declining adult abundance, the shift in age structure to younger fish means the reproductive potential declined. For example, the loss of large old fish during the fish kills means that even if the adult populations in the late 1980s and 2001 were the same size, the reproductive potential would have been lower in 2001.

Sucker population monitoring has been less intensive in other areas including Clear Lake, Gerber Reservoir, Lost River, Tule Lake, and the Klamath River (Reclamation 2000). In 2000, BRD sampled sucker populations on 10-20 occasions during the summer at Clear Lake and Gerber Reservoir. At Clear Lake a wide range of size groups of both Lost River and shortnose suckers were captured including juveniles (R. Shively, BRD, per. com.). This information along with relatively high catch per unit effort data suggests that sucker populations remain at levels similar to the last intensive survey in 1995 (Scopettone et al. 1995). Shortnose sucker catch rates were also relatively high for Gerber Reservoir with a wide range of sizes (R. Shively, per. com.). Biologists from the Bureau of Land Management have documented successful reproduction in tributaries to Gerber Reservoir almost every year since 1995 (A. Hamilton, BLM, per. com.). Overall, sucker populations in Gerber Reservoir and Clear Lake are relatively good.

In 1999, Reclamation and BRD conducted intensive fish sampling in the Lost River. Adult shortnose suckers were captured throughout the river with higher densities around Harpold Dam and Wilson Dam. Juvenile suckers were also commonly sampled (Shively et al. 2000). Low sucker catch rates occurred in the Lost River below Wilson Dam and above Miller Creek. Sucker populations appear to be relatively small but stable in the Lost River above Wilson Dam.

Reclamation has infrequently monitored spawning runs from Tule Lake on the Lost River below Anderson-Rose Dam. Small numbers of adult Lost River and shortnose suckers were observed every year between 1995-2000 (Reclamation 2000). Adults of both species were also captured from Tule Lake Sump as part of a radio tracking study in 1999 and 2000. Based on spawning run and lake monitoring over the last couple of years, the adult population of shortnose and Lost River suckers is probably less than 1,000 fish.

Pacificorp and Oregon State University monitored relative abundance of fish in Keno Reservoir during 2000. Few suckers were captured which is consistent with earlier surveys indicating low numbers of fish probably inhabit this area.

2. Juvenile Sucker Data

Oregon State University researchers have been monitoring seasonal abundance and distribution and habitat use yearly since 1991 (Simon et al. 2001). Very low juvenile abundance was monitored in 1992 and 1994. Juvenile abundance since 1995 has been variable. During the period 1995-1998, juvenile sucker abundance generally declined for both Lost River and shortnose suckers (Simon et al. 2000). However, in 1999 relatively large numbers of juvenile Lost River and shortnose suckers were sampled. Juvenile suckers abundance in 2000 was lower than 1999 and in 2001 juvenile sucker abundance was very low. Since 1991, relatively good juvenile survival has occurred in 1991 and 1993 and recruitment into the adult population. However, it is too soon to know if the juvenile suckers from 1995-2000 will survive until adults.

3. Sucker Habitat

Historically, suckers spawned in several tributaries (Williamson River/Sprague River, Wood River, Crooked Creek, Sevenmile Creek) and springs in UKL. Today, the Williamson River and Sprague River are the only tributaries supporting substantial spawning (USFWS 2001). The spawning habitat in these streams is degraded due to sedimentation and high plant nutrients that lead to dense algae and aquatic plant growth that adversely affects spawning success. In the lake, spawning currently occurs at only a few springs (Sucker, Silver Building, Ouxy, Cinder Flat, and Boulder). Others like Harriman Springs, Odessa Springs, and Barkley Springs no longer support sucker spawning.

Sucker habitat is degraded in Upper Klamath Lake and its tributaries because of poor water quality and habitat loss. Access is restricted to historic spawning areas in the Sprague River by a poorly designed fish ladder at Chiloquin Dam. Alteration of floodplains and riparian areas along the tributaries including Sprague River by flood control projects and non-Project agricultural uses had degraded historic spawning and juvenile rearing habitat. Grazing of tens of thousands of livestock in forest, rangeland, and agricultural lands, and intensive timber harvest and road construction in forested areas has accelerated erosion and sedimentation, and nutrient loading in the tributaries and UKL.

Diking and draining of wetlands around UKL by private interests for agricultural development have reduced wetland habitat by approximately 35,000 acres. These wetlands provided important rearing habitat for larval and juvenile suckers. They also functioned to remove plant nutrients and sediment from the inflows and lake water. Marsh vegetation decomposition substances released from the wetlands may have inhibited blue-green algae growth in the lake. Although approximately 15,000 acres of agricultural lands around the lake have been acquired by the federal government and The Nature Conservancy and are in various stages of restoration, they are not completely functional and reconnected to UKL.

Age 0 juvenile sucker refers to fish after hatching and before completion of their first winter. Age 0 suckers typically range from 10-75 mm. They are subdivided into larval (10-25 mm) and juvenile stages (>25 mm). Larval suckers typically are found in the Williamson River-UKL system from March through June and juveniles after April. The mouth of the Williamson River and Goose Bay are two areas known to have high concentrations of larval and juvenile suckers and are considered critical rearing grounds (Klamath Tribes 1996). Larval suckers are associated with emergent vegetation around the periphery of the lake and the edges of the lower Williamson River. Channelization and diking of the lower Williamson River by private interests has shortened and widened the river channel. Habitat complexity related to the previously highly sinuous river channel has been lost. Extensive willow and cottonwood riparian areas were eliminated. Floodplain habitat has been drastically reduced, and floodplain functions, such as nutrient removal, invertebrate production, and water storage are minimal in the lower river

section. Over the last century, private interests reclaimed large tracts of marshes by diking and dredging around the perimeter of UKL. Emergent vegetation habitat at Goose Bay has been greatly reduced as a result. Complex shoreline habitat in the lower Williamson and along the shoreline at Goose Bay is confined to narrow strips perched at relatively high elevations (Dunsmoor et al. 2000).

Grazing in both the Clear Lake and Gerber watersheds has previously destabilized streambank vegetation resulting in erosion, sedimentation, reduced quality of spawning gravel/cobble, increased water temperatures, and lower water tables. However, stream habitat although still degraded is in pretty good condition and appears to support viable sucker populations.

River habitat in the Lost River and Klamath River (Keno Reservoir) has been substantially altered by Project and non-project channelization, construction of diversion dams, and loss of riparian habitat. Sucker spawning and rearing habitat is generally in poor condition.

Tule Lake habitat is marginal for suckers because of its shallow depth (mostly less than 3 feet). In addition, spawning habitat in the Lost River is limited to a small gravel area below Anderson-Rose Dam.

4. Water Quality

The high algae productivity of UKL and associated poor water quality has been implicated as a major factor affecting the status of the suckers. Excessive blooms of the blue-green algae *Aphanizomenon flos-aquae* cause significant water quality deterioration due to photosynthetically elevated pH and to both supersaturated and low dissolved oxygen. Dissolved oxygen, pH, and ammonia achieve harmful and lethal levels in UKL, and as such are important variables affecting survival and the viability of sucker populations. The ultimate cause of the UKL water quality problem is excessive nutrients, especially nitrogen and phosphorus, due to natural inputs, external sources, and internal loading. However, sediment cores of the lake bottom show the nutrient budget has changed dramatically in the past 50-100 years (Eilers et al. 2001). Sediment cores show increase in the sediment accumulation rate, nitrogen and phosphorus concentrations, and a shift toward the nuisance alga responsible for existing poor water quality.

Upper Klamath Basin has extensive upwelling of groundwater containing nitrogen and phosphorus that enter UKL or contribute to tributary inflows. Multiple anthropogenic activities contribute nutrients to UKL, including cattle grazing, agricultural fertilizer, and drainage of wetlands (Bortleson and Fretwell 1993; Snyder and Morace 1997; Risely and Leanen 1999). Wetland soils of the Klamath Basin have a high percentage of organic matter, normally maintained in the soil as refractory material (undecomposed remains of plants) and not biologically available. Wetland drainage dries the soil, allows oxygenation, promotes aerobic bacteria that decompose refractory material and produce bio-available nutrients, which can enter UKL either via groundwater discharge or during seasonal pumping of drainage water. The production and export of external nutrient loads to UKL is exacerbated by loss of the filtering effects of wetlands and streamside riparian vegetation. These habitats filter and immobilize nutrients by capturing particulate matter suspended in surface run-off and by uptake of nutrients transported in groundwater (Gregory et al. 1991).

Internal loading is the liberation of nutrients from the lakebed into the water column. Nutrients bound to sediment are not biologically available until liberated into the water column. It is estimated that up to 61 percent of the annual phosphorus budget of UKL comes from internal loading (Kann and Walker 2000). Internal loading is particularly troublesome in UKL because it happens in summer when water quality already may be stressful to fish. The high pH, which can cause stress to fish, also initiates internal loading, triggering or maintaining algal blooms and further exacerbating the situation. A primary contributor to the annual budget of internally loaded nutrients is the decayed remains of previous years' algae.

Summer water quality in the Klamath River (Lake Ewauna to Keno) is generally poor, with large blue-green algae growth, high pH and ammonia levels, and low dissolved oxygen concentrations (CH2M HILL 1995). Poor water quality is associated with poor water quality entering from UKL, a high sediment oxygen demand, and a number of significant discharges with high biological oxygen demand. In addition, irrigation return flows enter this reach from the Lost River Diversion Canal and Klamath Straits Drain that frequently have poor water quality during the summer.

Water quality conditions in Clear Lake Reservoir and Gerber Reservoir are generally good. Algae growth is low to moderate, pH and dissolved oxygen levels remain within a range acceptable for suckers (Reclamation 2001).

Summer water temperatures are occasionally stressful in the shallower Clear Lake. Low dissolved oxygen conditions may occur during ice-cover conditions at extremely low lake levels.

In the Lost River, water quality conditions (temperature, pH, dissolved oxygen) are generally within acceptable levels for suckers (Reclamation 2001). However, high nutrient loading from natural and anthropogenic sources including agriculture, grazing, septic tanks, dairy operations, municipal sewage treatment facilities, and other sources occurs leading to large algae and aquatic plant growth during the summer. This excessive plant growth impacts the Lost River water quality. Dissolved oxygen and pH levels are high during the day as a result of photosynthetic activity and low at night when the plants respire. The low dissolved oxygen condition may be stressful to fish.

At Gerber Reservoir, water quality conditions are generally good. Algae growth is moderate and water temperature, pH, and dissolved oxygen are within

4.5.2 Baseline Condition of Coho Salmon

Limited information exists regarding present coho salmon abundance in the Klamath River Basin. Adult counts in a few Klamath River tributaries and juvenile trapping on the Klamath River mainstem and tributaries provide valuable information on presence of coho salmon in specific areas during key time periods, but less valuable for determining population status or trends (NMFS 2001). However, they do provide some indication of low abundance and the precarious status of coho salmon populations in the Klamath River Basin.

1. Adult Data

Between 1991 and 2000, adult coho salmon counts using weir and video observations in the Shasta River ranged from 0 to 24 fish, with 1 or 0 fish counted during four of these years. Counting weirs in the Scott River indicated an average of 4 fish (range 0-24) between 1991 and 2000. One of those years accounted for approximately 65 percent of the total number of coho observed and zero coho were observed in four years. Coho salmon were observed in the Scott River during this period as early as September 21. In Bogus Creek, an average of 4 coho adults (range 0-10) were counted at the weir. These data emphasize the importance that one year's spawning success can have on the survival of these coho salmon stocks.

Coho salmon counts in the Trinity River are mostly of hatchery origin, and 100 percent marking of hatchery coho salmon has only recently occurred so estimates of naturally-produced coho are only available since the 1997 return year. The results of counting from these three years yielded an estimated 198, 1,001, and 491 naturally produced adult coho salmon for the 1997-1998, 1998-1999, and 1999-2000 seasons, respectively (CDFG 2000). Coho salmon were first observed at the Trinity River weir during the week of September 10 during the 1999-2000 trapping season (CDFG 2000).

2. Juvenile Data

Recent smolt data suggests that Klamath Basin coho salmon stocks are in trouble. Juvenile traps, operated on the river's mainstem, were used to estimate indices of smolt production. Based on counts from these traps between 1991 and 2000, the annual average number of wild coho salmon smolts was estimated at only 548 individuals (range 137-1,268)(FWS 2000). For the same period, an average output of 2,975 wild coho salmon smolts (range 565-5,084) was estimated for Willow Creek, within the Trinity sub-basin (USFWS 2000). The incomplete trapping record provides limited information in terms of temporal trends, but it still is a useful indicator of the extremely small size of coho salmon populations in the Klamath Basin.

The FWS operates downstream juvenile migrant traps on the mainstem Klamath River at Big Bar (River Mile 48). The incomplete trapping record provides limited information in terms of abundance or trends, but does indicate the presence of coho at different life stages during certain times of the year (NMFS 2001). Indices of abundance are calculated from actual numbers trapped. In 2001, coho salmon smolts from trapping at Big Bar resulted in an actual total count of 23 fish between April 9 and July 22; 14 which were considered wild (FWS 2001). Trapping was discontinued after July 22 because of heavy algal loading in the traps. This data is preliminary (Bill Pinnix, personal communication, 2002).

A 1997 FWS report and 2001 mainstem trap data (CDFG unpublished) show that young-of-the-year coho salmon are emerging from the Shasta and Scott rivers, where they probably were spawned, into the mainstem of the lower Klamath River between March and August. Considering the low numbers of coho salmon fry that have been reported from these sub-basins, it is unlikely that these fish were displaced downstream because of competitive interactions with other juveniles of their own species. Instead, the most likely explanation for their summer movement is that declining water quality and quantity in the lower-order tributaries force these young fish to seek refuge elsewhere. Thus, they end up in the river's mainstem earlier than in other river systems. This is exploratory behavior and movement in search for adequate nursery habitat has been well documented, especially before the onset of winter (Sandercock 1991).

3. Habitat

Anadromous salmonids in the Klamath River are restricted to the mainstem Klamath River and tributaries below Iron Gate Dam. No passage facilities exist at Iron Gate or Copco dams, which are owned and operated by PacifiCorp.

Coho salmon still occur in the Klamath River and its tributaries (CH2M Hill 1985; Hassler et al. 1991). Between Seiad Valley and IGD, coho salmon populations are believed to occur in Bogus Creek, Shasta River, Humbug Creek, Empire Creek, Beaver Creek, Horse Creek, and Scott River (NMFS 1999b). Between Orleans and Seiad Valley, coho salmon populations are believed to occur in Seiad Creek, Grider Creek, Thompson Creek, Indian Creek, Elk Creek, Clear Creek, Dillon Creek (suspected), and Salmon River (NMFS 1999b). Finally, between Orleans and Klamath (mouth of the river), coho salmon populations are believed to occur in Camp Creek, Red Cap Creek, Trinity River, Turwar Creek, Blue Creek, Tectah Creek, and Pine Creek (NMFS 1999b). It is estimated that Shasta River presently maintains approximately 38 miles of coho habitat, which is below pre-development levels (INSE 1999). Available data suggests that existing coho salmon habitat in the Scott River now constitutes approximately 88 miles (INSE 1999).

Unscreened or ineffectively screened diversions are common in the Shasta and Scott Rivers resulting in substantial entrainment and fish stranding. Downstream migrants are also trapped in pools or side channels when stream flows drop sharply during early summer and soon die from high temperatures, lack of food, or predation. Some portions of streams often become entirely dewatered due to diversion. A recent inventory of diversion ditches possibly affecting salmonids in the Scott River indicates an estimated 125 unscreened ditches (Sommarstrom 1994). To date, CDFG has screened 30 diversions throughout the Scott River. Coho salmon juveniles are very susceptible to diversions because they need to spend at least one full summer in the stream.

Reclamation participated on a technical committee for the Hardy Phase II study to develop flow recommendations necessary to aid restoration efforts of aquatic resources within the mainstem Klamath River. This effort included the development of habitat versus flow relationships for various anadromous salmonids in the Klamath River, including coho salmon. Reclamation recognizes that there is a level of uncertainty with these relationships. For example, much of the recently developed site-specific habitat suitability criteria used data obtained during 1998 and 1999, which were "average" to "above average" water years with relatively high springtime river releases. However, Reclamation's view is that until additional data are collected to refine these habitat relationships, the Phase II habitat-flow relationships are appropriate for use in this BA because: (1) the habitat-flow relationships were developed following general Instream Flow Incremental Methodology (IFIM) guidelines (Bovee et al. 1998; Milhous et al. 1989; Bovee 1986); and (2) the habitat-flow relationships were developed by a team of professional fishery biologists representing various entities with extensive experience conducting instream flow studies using IFIM, including Dr. Hardy, and with knowledge of current biological needs of anadromous salmonids (e.g., edge habitat for fry life stages) in the Klamath River mainstem. This information was used in Chapter 5.0 Effects Analysis for Coho Salmon. Presently, the draft Phase II report is available for public review.

Table 4.14 summarizes preliminary Phase II flow recommendations at Iron Gate Dam. These flow recommendations relied on simulated hydrology to estimate the "unimpaired flows" at Iron Gate Dam as reference conditions (Hardy and Addley 2001). Reclamation did not use these flow recommendations because use of (unimpaired flows" is inconsistent with Reclamation's understanding of the appropriate environmental baseline is use of "impaired flows" at Iron Gate Dam, without the Project. The Hardy Phase II flow recommendations were not used in the analysis of effects on coho salmon (Chapter 5.0).

Table 4.14 - Phase II monthly flow recommendations for the Iron Gate to Shasta River Reach for the 10 to 90 percent exceedence flow levels.

Exceedence	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
10	4200	5000	5400	5200	4500	3800	2300	1800	1840	1900	2200	3500
20	3585	4250	4850	4650	4100	3350	2135	1635	1705	1780	2085	2950
30	2970	3500	4300	4100	3700	2900	1970	1470	1570	1660	1970	2400
40	2685	3110	3850	3700	3400	2600	1750	1360	1460	1565	1840	2215
50	2400	2720	3400	3300	3100	2300	1530	1250	1350	1470	1710	2030
60	2200	2460	2900	2750	2600	2050	1390	1125	1225	1335	1555	1815
70	2000	2200	2400	2200	2100	1800	1250	1000	1100	1200	1400	1600
80	1750	1900	2000	1900	1850	1575	1125	1000	1050	1150	1300	1450
90	1500	1600	1600	1600	1600	1350	1000	1000	1000	1100	1200	1300

4. Water Quality

The combined effects of high temperatures, high nutrient concentrations, and low dissolved oxygen levels during the summer months can create extremely stressful conditions for coho salmon and other salmonids in the Lower Klamath River. High nutrient concentrations and associated increase in the abundance of algae and aquatic plants tend to lead to increased sedimentation and water temperatures, slower velocities, and lower dissolved oxygen. In June of 2000, temperatures and dissolved oxygen levels reached critical levels in the Klamath River and resulted in a large fish kill of juvenile salmonids (CDFG 2000). No major fish kills were reported in the mainstem Klamath River during summer 2001.

High nutrient concentrations in the Klamath River come from the Upper Klamath Basin where anthropogenic sources contribute significantly. Widespread grazing, agriculture, logging and conversion of wetland to agricultural land have increased nutrient loading. Most lakes in the Upper Klamath Basin are shallow and water temperatures closely track air temperatures. Thus, flows originating from the headwater areas are naturally warm during the summer.

5. Critical Dry Water Year Water Quality Analysis (Applicable to summer of 2001)

a. Water Temperature

Temperature dynamics in the Klamath River below Iron Gate Dam are affected by upstream reservoirs, local meteorological conditions, regulation of releases to the Klamath River, quantity of release to the Klamath River and tributary contributions (Deas 2001). Water quality model simulations using the RMA-11 model by Deas (2001) resulted in the following conclusions:

- Under drought conditions tributary contributions are typically small
- Under typical summer flows, operation of the Klamath River dams produces predictable “nodes” of minimum temperature variation separated by a one-day travel time in the river (at mean velocity). These phenomenon, apparent in sub-daily data and simulations, are critical in interpreting sub-daily water temperature information
- Seasonal changes are apparent in the system as well as short term climatic meteorological conditions
- Iron Gate Reservoir (and possibly Copco Reservoir) affect the thermal regime of the downstream river in three principle ways (under current operating conditions)
 - In mid-to late spring Iron Gate flows are often well below equilibrium temperature, maintaining a “cool” water release to the Klamath River
 - In summer, there is minimal cool water benefit to the Iron Gate flows (with respect to anadromous fishes). The flows at Iron Gate Dam are still below equilibrium temperature, but only by a modest amount. However, the flow does moderate the daily maximum and minimum temperature.
 - In fall, for short periods, the Iron Gate Dam flows can be warmer than equilibrium. Under such conditions, the flows are a heat source to the river.

b. Dissolved Oxygen

Dissolved oxygen (DO) dynamics in the Klamath River below Iron Gate Dam are complex. DO concentration of releases, nutrient availability, and primary production directly affects DO concentration in space and time. A few notable remarks include:

- Simulated mean Klamath River DO (as depicted in longitudinal profiles) illustrates that throughout most of the summer daily mean DO concentrations are fairly constant throughout the river reach. However, in the fall, DO at Iron Gate dam begin to decrease.
- Further examination of the daily mean DO profiles illustrates that there is potentially appreciable primary production immediately below Iron Gate Dam, shown by a slightly increased daily mean DO.
- Examination of the simulated time series suggests that seasonally (and spatially) primary production directly and appreciably impacts sub-daily dissolved oxygen levels.
- The various flow regimes had a modest impact on daily mean DO concentration. The lower flows did produce a slightly higher mean daily DO, possibly due to increased aeration at shallower depths. Sub-daily data were more highly variable between alternatives, but these data have not been critically assessed at this time to provide an explanation for this response.

c. Tributary Contributions: Flow

Flows during the 2001 period (those used to determine accretions as well as assign to the Shasta and Scott Rivers) were representative of a drought year. Thus, during much of the simulation period they were small and often negligible. There was even a simulation period when accretions were negative, suggesting that the river flow at Seiad Valley was less than the release at Iron Gate Dam. Thus, the impacts of tributary flow on water quality were modest. This is not always the case. Often early June contributions from the Scott River are appreciable and can have an appreciable impact on water quality downstream of River Mile 143 (mouth of the Scott River). Likewise, summer period flows in the Shasta River are sometimes on the order of 100 cfs. For example, if Klamath River flows were reduced to 600 cfs then the Shasta River contribution can have larger effect.

Shasta River

Shasta River flow experienced a daily averaged flow of 25.6 cfs from June 1 through September 30, 2001. Although maximum flow was just less than 100 cfs, the standard deviation over the period was just under 9 cfs. For most of the period, the Shasta River experienced flows on the order of 25 cfs. There was no remnant of the spring hydrograph in the Shasta River flow record, but there was apparent that irrigation dropped off after about September 26.

Scott River

Scott River flow experienced a daily averaged flow of about 15 cfs from June 1 through September 30, 2001. Although maximum flow was just over 100 cfs, the standard deviation over the period was just about 6 cfs. For most of the period, the Scott River experienced flows on the order of 15 cfs. Scott River flows differed from Shasta River in that there was a remnant of the spring hydrograph present. However, these flows diminished by June 16. Scott River flows did not recover in late September as they did in the Shasta River

Accretions

Accretions were updated for 2001 conditions as well because tributary inflow between Iron Gate Dam and Seiad Valley is appreciably less in critically dry years. To estimate accretions the flow at tributary inflow from the Shasta and Scott Rivers was subtracted from flows below Iron Gate Dam. This value was compared to Klamath River flow at Seiad Valley.

Through about the third week in June, accretions were positive, i.e., there was net inflow from ungaged tributaries between Iron Gate Dam and Seiad Valley. However, from Late June through early August (with the exception of a few days) accretions were negative (depletions). That is, flow at Seiad Valley was less than flow at Iron Gate, including the additions of the Shasta and Scott Rivers. From mid-August to mid-September, accretions were essentially negligible, and after mid-September accretions once again began to pick up, but remained small. The spring period response is expected for a dry year in the Klamath basin when snowpack is small and exhausted early. Likewise, the fall period increases in baseflow are consistent with water resources development and meteorological and hydrological conditions.

It is apparent that the current drought condition in the basin has markedly affected tributary contribution to the Klamath River between Iron Gate Dam and Seiad Valley, as illustrated by the depletion or lack of appreciable accretion within this reach during much of the summer. For modeling purposes, accretion was set as outlined below. Accretions were added to the model at RM 180, RM 161, and RM 131. A portion of the accretion is also assigned to the Scott River between Ft. Jones and the confluence with the Klamath River. For further details on the assignment of accretions to the individual locations, refer to Deas and Orlob, 1999 (*Klamath River Modeling Project*, Sponsored by the US Fish and Wildlife Service, Klamath Basin Fisheries Task Force. Project #96-HP-01. December)

Table 4.15 - Monthly accretions used in all simulations

Date	Accretion (cfs)
June 1 – June 16	100
June 16 – August 10	-20
August 10 – September 15	0
September 15- September 30	25

Real-time data (15 minute interval or less) were downloaded from the California Data Exchange Center (CDEC) and are presented as preliminary by USGS. Daily average data were used as model input. The stations used in this analysis are discussed below.

Klamath River below Iron Gate Dam flows (2001): Data are from USGS Klamath River below Iron Gate Dam (KIG). Data quality summary: data difficult to process, because on varied interval. Processed period when flow changes occurred, e.g., June. Other months set to steady state flow of 1020-1040 cfs based on review of data. Missing periods from a few days

Shasta River flows (2001): Data are from USGS Shasta River near Yreka (SRY). Data quality summary: missing parts of a few days

Scott River flows (2001): Data are from USGS Scott River near Ft Jones (SFJ). Data quality summary: missing several days and parts of several days

Klamath River near Seiad Valley flows (2001) – Data are from USGS Klamath River near Seiad Valley (KSV). Data quality summary: missing portions of many days in June, few days in other months. One erroneous point on 9/2/01 (sudden increase from 1030 cfs to roughly 1750 cfs)– corrected

6. Water Quality Data

Water quality data form boundary conditions at three locations within the study reach: Iron Gate Dam, Shasta River, and Scott River. Accretions being uncertain in space and time throughout the river each are not assigned any inflow quality (in addition, accretions are almost negligible for the period of this analysis).

Due to time limitations, 1996 data were used. However, water quality data from 1996 was compared with the data from the comprehensive monitoring program completed in 2000 and found to be roughly comparable.

7. Meteorological Data

Available air temperature from the California Department of Forestry station at Brazie Ranch compared for the May 1 through October 31 period for 1996, 1997, 2000 and 2001. The warmest year was found to be 1996. 1996 meteorological data was used in this analysis. It should be noted that although air temperature is often viewed as an indicator of general climate response (e.g., warm, average, cold), it is only one of several meteorological parameters that may affect water temperature. Further, water resources development, operations, and hydrology play fundamental roles in thermal response of aquatic systems.

Table 4.16 - Comparison of air temperatures

Year (5/1-10/31)	# Hours >100°F	# Hours >90°F	# Hours >80°F
1996	122	356	840
1997	101	236	687
2000	0	179	685
2001*	0	227	719

* data only available through 9/9/01

8. Summary

All actions described as part of the environmental baseline have led to the current status of coho salmon in the Klamath River Basin. Coho are restricted to the mainstem Klamath River and tributaries below Iron Gate Dam. No passage facilities exist at Iron Gate or Copco dams, which are owned and operated by PacifiCorp. Available recent information suggests adult populations are small to nonexistent in some years. Existing information also indicates that adult coho salmon are present in the Klamath River in early September and juvenile coho salmon are present in the mainstem Klamath River year round.

4.5.3. Baseline Hydrology

Reclamation developed a hydrologic baseline for the BA that reflects the effects of non-Project activities and, in accordance with ESA implementing regulations, excludes the effects of proposed action from the baseline. This approach is taken to provide quantitative information to both Reclamation and the Services to assist in analyzing the effects of the proposed action on the species and to more readily model the effects of the proposed action compared to the baseline action.

The hydrologic component of the environmental baseline includes the seasonal analysis of several data sets representing multi-year dry, normal, and wet weather conditions. The baseline hydrological figures incorporate average Upper Klamath Lake elevations and Klamath River flows at Iron Gate Dam that would result if the Klamath Project was not operated. This simulates only non-Project flow depletions occurring upstream from Upper Klamath Lake. KPOPSIM used net (i.e. “impaired”) inflows using a hydrologic time series data set of flows at Iron Gate Dam with time steps from 1961-2000 developed by Philips Williams Associates (PWA 2001). Tables 4.17 and 4.18 summarize baseline flows at Iron Gate Dam and Upper Klamath Lake elevations by water year type. These flows and elevations were generated by PWA (2001) with “no Klamath Project operation” but with physical facilities in place.

Table 4.17- Baseline flows at Iron Gate Dam (values in cfs) by water year type

Time step	Above Average (19)		Below Average (11)		Dry (5)		Critical Dry (2)	
	Min	Ave	Min.	Ave.	Min.	Ave.	Min.	Ave.
April 1-15	3215	4793	2605	2978	1877	2251	1590	1627
April 16-30	3357	4783	2491	2919	1717	2088	1572	1584
May 1-15	3409	4295	2156	2582	1794	1939	1362	1515
May 16-31	3115	4049	1901	2366	1713	1811	1175	1369
June 1-15	2420	3317	1552	1956	1369	1485	994	1045
June 16-30	1985	2834	1246	1692	1148	1313	847	897
July 1-15	1613	2180	1133	1398	838	1002	711	746
July 16-31	1222	1723	961	1183	651	827	645	668
August	1078	1373	753	1064	689	805	577	600
September	912	1331	861	1097	723	892	650	651
October	1038	1565	1120	1368	972	1084	795	811
November	1384	2050	1447	1986	1374	1762	1126	1136
December	1639	2676	1384	2832	1643	2636	1445	1516

January	1819	3243	1772	3240	1730	2950	1953	2097
February	2105	4315	2403	3133	2001	2521	1630	1774
March 1-15	3176	4760	2750	3270	2213	2749	1745	1791
March 15-31	3129	5010	2802	3283	2246	2739	1726	1783

Table 4.18- Baseline Upper Klamath Lake elevations by water year type

	Above Average (19)		Below Average (11)		Dry (5)		Critical Dry (2)	
	Min	Ave	Min.	Ave.	Min.	Ave.	Min.	Ave.
April 1-15	4141.7	4142.4	4141.2	4141.5	4140.9	4141.1	4140.6	4140.6
April 16-30	4141.8	4142.4	4141.1	4141.5	4140.8	4141.0	4140.6	4140.6
May 1-15	4141.8	4142.2	4141.0	4141.3	4140.7	4140.8	4140.3	4140.4
May 16-31	4141.6	4142.1	4140.8	4141.1	4140.7	4140.7	4140.2	4140.3
June 1-15	4141.2	4141.7	4140.6	4140.9	4140.4	4140.5	4139.9	4140.1
June 16-30	4141.0	4141.4	4140.4	4140.7	4140.3	4140.4	4139.7	4139.9
July 1-15	4140.6	4141.0	4140.2	4140.4	4140.1	4140.2	4139.7	4139.8
July 16-31	4140.2	4140.6	4140.0	4140.2	4139.9	4140.0	4139.7	4139.7
August	4140.0	4140.3	4139.9	4140.1	4139.8	4139.9	4139.6	4139.6
September	4140.1	4140.4	4140.1	4140.2	4139.9	4140.0	4139.7	4139.7
October	4140.3	4140.7	4140.3	4140.6	4140.1	4140.3	4140.0	4140.0
November	4140.5	4141.1	4140.5	4141.0	4140.5	4140.9	4140.4	4140.5
December	4140.8	4141.4	4140.7	4141.4	4140.6	4141.3	4140.6	4140.7
January	4140.8	4141.6	4140.9	4141.6	4140.7	4141.4	4140.9	4141.0
February	4140.9	4142.1	4141.1	4142.1	4140.9	4141.2	4140.7	4140.7
March 1-15	4141.4	4142.3	4141.2	4142.3	4140.9	4141.2	4140.6	4140.7
March 16-31	4141.4	4142.4	4141.3	4142.4	4141.0	4141.2	4140.6	4140.6

“Without Project Operation” figures in the following analyses refer to a hydrologic baseline with no agriculture or refuge deliveries and only net inflow into Upper Klamath Lake (PWA 2001), but with all physical facilities in place. Average flows for each time step and water year type were calculated from this data set. The KPOPSIM model run assumed that outflows from Upper Klamath Lake are controlled by the original reef elevation at the outlet of Upper Klamath Lake to the Link River. Flows at Iron Gate Dam were computed by adding the following to Link River flows: (1) accretions to Lake Ewauna; (2) Area A2 winter runoff; (3) Lower Klamath Lake runoff to Klamath Straights and; (4) flow accretions between Keno Dam and Iron Gate Dam. The total effect on the listed species will be comprised of the specific effects of the proposed action combined with the baseline condition and other identified effects.

CHAPTER 5.0 - EFFECTS OF THE PROPOSED ACTION

5.1 INTRODUCTION

“Effects of the action” refers to the direct and indirect effects of a proposed action on listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects on the species. 50 CFR § 402.02.

For the purposes of this BA, effects on listed species and critical habitat are analyzed individually with respect to the proposed action (i.e. diversion, storage, and release or delivery of water). In accordance with the provisions of the ESA implementing regulations and the FWS SECTION 7 HANDBOOK, Reclamation used the following definitions to make its effects determinations for each listed species:

“Likely to adversely affect:” Any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of “is not likely to adversely affect”). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action “is likely to adversely affect” the listed species. If incidental take is anticipated to occur as a result of the proposed action, an “is likely to adversely affect” determination should be made.

“Not likely to adversely affect:” Effects on listed species are expected to be discountable, insignificant, or completely beneficial. “Beneficial effects” are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

“No effect:” when the action agency determines its proposed action will not affect listed species or critical habitat.

As part of analyzing the effects of the proposed actions on the species, this section of the BA provides information about river flows and lake elevations that will likely result from the proposed action. Reclamation has provided this information to help analyze the effects of the proposed action and to assist FWS and NMFS in developing coordinated biological opinions. However, maintenance of precise lake levels and river flows are not the actions upon which Reclamation is consulting in this BA; rather they are an anticipated results of the proposed action for which effects are evaluated. The effects analysis compares the effects of the proposed action to the environmental baseline.

5.2 EFFECTS ON ENDANGERED LOST RIVER AND SHORTRIVER SUCKERS

5.2.1 Upper Klamath Lake

Reclamation compared lake elevations resulting from the proposed action with those in the environmental baseline, where inflow is routed through the reservoir at a gate opening of 4139 and no Project diversion, artificial storage, or delivery takes place (Table 5.1). Maximum lake levels are not addressed because they are subject to PacifiCorp’s flood release criteria outlined in its *Klamath Project Guide for High Runoff Season Operation*. These criteria are incorporated into Reclamation’s Standing Operating Procedures for Link River Dam and Upper Klamath Lake. As such, they are not discretionary actions subject to Reclamation’s control and are not related to this analysis.

5.2.2 Analysis Approach

To determine the effects of the proposed action on endangered Lost River and shortnose suckers in Upper Klamath Lake, Reclamation compared lake elevations and habitat quantity for the proposed action and the environmental baseline. For each time step, the proposed action minimum and average elevations were calculated using the KPOPSIM model. These elevations were compared to baseline elevations computed using the MIKE 11 hydrodynamic model (PWA 2001). Differences in elevation were evaluated qualitatively for effects on water quality. Quantitative habitat data used included shoreline spawning habitat (Table 5.2), emergent vegetation habitat for larval and juvenile suckers (Table 5.3), and open water habitat for adult suckers (Table 5.4). Maximum values are at a full pool elevation of 4143.3. A change in habitat with the proposed action compared to baseline is assessed for each water year type and time step (Table 5.5).

Shoreline spawning habitat values less than maximum may result in lower spawning success and smaller year classes. A reduction in the emergent vegetation habitat below the maximum may result in lower survival of larval and juvenile suckers and resulting year class size. As open water habitat for adult suckers decreases from the maximum, juvenile and adult suckers may become more crowded potentially leading to increased stress, disease and increased risk of fish kills. They may also be relegated to areas of lower habitat quality and poor water quality resulting in an increased risk of fish kills leading to smaller sucker populations.

Table 5.1 – Comparison of minimum UKL elevations resulting from the proposed action with the environmental baseline by water year type and time step.

Water Year	Time Step	Baseline minimum elevation	Proposed Action minimum	Difference (feet)	Baseline average elevation	Proposed Action average	Difference (feet)
Above Average	October	4140.3	4139.4	-0.9	4140.7	4139.9	-0.8
	November	4140.5	4139.7	-0.8	4141.1	4140.0	-1.1
	December	4140.8	4140.5	-0.3	4141.4	4140.5	-0.9
	January	4140.8	4141.0	+0.2	4141.6	4141.0	-0.6
	February	4140.9	4140.3	-0.6	4142.1	4141.6	-0.5
	March 1-15	4141.4	4142.0	+0.6	4142.3	4142.0	-0.3
	Mar. 16-31	4141.4	4142.3	+0.9	4142.4	4142.3	-0.1
	April 1-15	4141.7	4142.5	+0.8	4142.4	4142.5	+0.1
	April 16-30	4141.8	4142.3	+0.5	4142.4	4142.6	+0.2
	May 1-15	4141.8	4142.2	+0.4	4142.2	4142.6	+0.4
	May 16-31	4141.6	4142.0	+0.4	4142.1	4142.6	+0.5
	June 1-15	4141.2	4141.7	+0.5	4141.7	4142.3	+0.6
	June 16-30	4141.0	4141.3	+0.3	4141.4	4142.3	+0.9
	July 1-15	4140.6	4141.0	+0.4	4141.0	4141.8	+0.8
	July 16-31	4140.2	4140.6	+0.4	4140.6	4141.4	+0.8
	August	4140.0	4139.8	-0.2	4140.3	4140.6	+0.3
	September	4140.1	4139.3	-0.8	4140.4	4140.6	+0.2
Below Average	October	4140.3	4139.3	-1.0	4140.6	4139.7	-0.9
	November	4140.5	4139.7	-0.8	4141.0	4139.9	-1.1
	December	4140.7	4140.1	-0.6	4141.5	4140.5	-1.0
	January	4140.9	4141.0	+0.1	4141.6	4141.0	-0.6
	February	4141.1	4141.7	+0.6	4141.5	4141.7	+0.3
	March 1-15	4141.2	4142.0	+0.8	4141.6	4142.0	+0.4
	March 16-31	4141.3	4142.3	+1.0	4141.6	4142.3	+0.7
	April 1-15	4141.2	4142.5	+1.3	4141.5	4142.5	+1.0
	April 16-30	4141.1	4142.3	+1.2	4141.5	4142.5	+1.0
	May 1-15	4141.0	4142.2	+1.2	4141.3	4142.3	+1.0
	May 16-31	4140.8	4142.0	+1.2	4141.1	4142.1	+1.0

	June 1-15	4140.6	4141.7	+1.1	4140.9	4141.7	+0.8
	June 16-30	4140.4	4141.3	+0.9	4140.7	4141.4	+0.7
	July 1-15	4140.2	4141.0	+0.8	4140.4	4141.0	+0.6
	July 16-31	4140.0	4140.6	+0.6	4140.2	4140.6	+0.4
	August	4139.9	4139.8	-0.1	4140.1	4139.9	-0.2
	September	4140.1	4139.3	-0.8	4140.2	4139.5	-0.7
Dry	October	4140.1	4137.4	-2.7	4140.3	4138.0	-2.3
	November	4140.5	4137.8	-2.7	4140.9	4139.0	-1.9
	December	4140.6	4138.1	-2.5	4141.3	4140.0	-1.3
	January	4140.7	4139.1	-1.6	4141.4	4140.8	-0.6
	February	4140.9	4141.1	+0.2	4141.2	4141.6	+0.4
	March 1-15	4140.9	4141.3	+0.4	4141.2	4141.8	+0.6
	Mar. 16-31	4141.0	4141.2	+0.2	4141.2	4141.9	+0.7
	April 1-15	4140.9	4141.0	+0.1	4141.1	4141.7	+0.6
	April 16-30	4140.8	4140.6	-0.2	4141.0	4141.6	+0.6
	May 1-15	4140.7	4140.6	-0.1	4140.8	4141.5	+0.7
	May 16-31	4140.7	4140.6	-0.1	4140.7	4141.4	+0.7
	June 1-15	4140.4	4140.1	-0.3	4140.5	4140.9	+0.4
	June 16-30	4140.3	4139.5	-0.8	4140.4	4140.4	0.0
	July 1-15	4140.1	4139.0	-1.1	4140.2	4139.8	-0.4
	July 16-31	4139.9	4138.6	-1.3	4140.0	4139.2	-0.8
	August	4139.8	4137.8	-2.0	4139.9	4138.3	-1.6
	September	4139.9	4137.2	-2.7	4140.0	4137.8	-2.2
Critical Dry	October	4140.0	4137.2	-2.8	4140.0	4137.2	-2.8
	November	4140.4	4137.7	-2.7	4140.5	4137.8	-2.7
	December	4140.6	4137.9	-2.7	4140.7	4138.1	-2.6
	January	4140.9	4139.0	-1.9	4141.0	4139.3	-1.7
	February	4140.7	4139.4	-1.3	4140.7	4140.4	-0.3
	March 1-15	4140.6	4139.6	-1.0	4140.7	4140.7	0.0
	March 16-31	4140.6	4139.9	-0.7	4140.7	4141.0	+0.3
	April 1-15	4140.6	4140.0	-0.6	4140.6	4141.0	+0.4
	April 16-30	4140.6	4140.0	-0.6	4140.6	4140.9	+0.3
	May 1-15	4140.3	4139.8	-0.5	4140.4	4140.7	+0.3
	May 16-31	4140.2	4139.5	-0.7	4140.3	4140.5	+0.2
	June 1-15	4139.9	4139.2	-0.7	4140.1	4140.0	-0.1
	June 16-30	4139.7	4138.8	-0.9	4139.9	4139.6	-0.3
	July 1-15	4139.7	4138.5	-1.2	4139.8	4139.1	-0.7
	July 16-31	4139.7	4138.1	-1.6	4139.7	4138.5	-1.2
	August	4139.6	4137.4	-2.2	4139.6	4137.6	-2.0
	September	4139.7	4137.0	-2.7	4139.7	4137.1	-2.6

Table 5.2 - Spawning habitat-lake level relationship for endangered suckers at known shoreline spawning areas (average of Cinder Flat, Ouxy Springs, Silver Building Springs and Sucker Springs; BRD 2001).

Lake elevation (feet)	Shoreline spawning habitat-percent inundated
4143.3	100.0
4143.0	95.1
4142.5	90.5
4142.0	73.8

4141.5	62.0
4141.0	49.8
4140.5	36.7
4140.0	30.2
4139.5	17.6
4139.0	13.8
4138.5	7.3
4138.0	5.2
4137.5	0.0
4137.0	0.0

Table 5.3 - Emergent vegetation habitat-lake elevation relationships for endangered larval and juvenile suckers at heavily used areas including the lower Williamson River, and Tulana, and Goose Bay sites combined (Dunsmoor et al. 1999).

Lake elevation (feet)	Lower Williamson (percent inundated)	Tulane and Goose Bay (percent inundated)
4143.3	100.0	100.0
4143.0	83.6	87.1
4142.5	56.6	68.0
4142.0	33.2	50.2
4141.5	15.4	34.4
4141.0	4.4	20.4
4140.5	0.8	10.1
4140.0	0.0	3.9
4139.5	0.0	1.3
4139.0	0.0	0.0
4138.5	0.0	0.0
4138.0	0.0	0.0
4137.5	0.0	0.0
4137.0	0.0	0.0

Table 5.4 - Adult rearing habitat-lake elevation relationships for endangered adult suckers in the northern portion of UKL where most radio-tagged fish were located (Peck 2000).

Upper Klamath Lake elevation (feet)	Northern portion of Upper Klamath Lake (percent area > 3 feet deep).
4143.3	100.0
4143.0	99.9
4142.5	99.8
4142.0	99.7
4141.5	98.9
4141.0	98.1
4140.5	93.9
4140.0	89.7
4139.5	78.6
4139.0	67.4
4138.5	60.2

4138.0	53.2
4137.5	48.1
4137.0	43.1

Table 5.5 - Percent of maximum adult rearing, shoreline spawning, and emergent vegetation habitat in Upper Klamath Lake resulting from the proposed action (average elevations) compared to environmental baseline. (Maximum habitat is available at “full pool” elevation 4143.3).

Water Year	Time Step	Adult Habitat Baseline	Adult Habitat Proposed	Percent Change	Shore Spawn Habitat BL	Shore Spawn Proposed	Percent Change	Emergent Habitat UKL Baseline	Emergent Habitat UKL Proposed	Percent Change	Williamson Baseline Habitat	Williamson Proposed	Percent Change
AA	Oct.	95.6	89.5	-6.1				13.7	3.0	-10.7			
	Nov.	98.3	89.7	-8.6				23.0	4.0	-19.0			
	Dec.	98.7	93.9	-4.8				31.2	10.1	-21.1			
	Jan.	99.1	98.1	-1.0				37.4	20.4	-17.0			
	Feb.	99.7	99.1	-0.6	76.9	64.3	-12.6	53.7	37.4	-16.3			
	Mar 1-15	99.7	99.7	0.0				60.9	50.2	-10.7			
	Mar 16-31	99.7	99.7	0.0	86.9	83.6	-3.3	64.4	60.9	-3.5			
	April 1-15	99.7	99.8	+0.1				64.4	68.0	+3.6			
	April 16-30	99.7	99.8	+0.1	86.9	91.1	+4.2	64.4	71.7	+7.3	51.5	61.8	+10.3
	May 1-15	99.7	99.8	+0.1				57.2	71.7	+14.5			
	May 16-31	99.7	99.8	+0.1	76.9	91.1	+14.2	53.7	71.7	+18.0	37.4	61.8	+24.4
	June 1-15	99.2	99.7	+0.5				40.5	60.9	+20.4			
	June 16-30	98.3	99.7	+1.4				31.2	60.9	+29.7	12.6	46.6	+34.0
	July 1-15	98.1	99.4	+1.3				20.4	43.7	+23.3			
	July 16-31	94.7	98.7	+4.0				11.8	31.2	+19.4	0.8	12.6	+11.8
	August	92.2	94.7	+2.5				7.7	11.8	+4.1			
	September	93.1	94.7	+1.6				8.9	11.8	+2.9			
BA	October	94.7	83.0	-11.7				11.8	2.0	-9.8			
	November	98.1	87.5	-10.6				20.4	2.0	-18.4			
	December	98.9	93.9	-5.0				34.4	3.0	-31.4			
	January	99.1	98.1	-1.0				37.4	20.4	-17.0			
	February	98.9	99.2	+0.3	61.9	66.6	+4.7	34.4	40.5	+6.1			
	Mar 1-15	99.1	99.7	+0.6				37.4	50.2	+12.8			
	Mar 16-31	99.1	99.7	+0.6	64.3	83.6	+19.3	37.4	60.9	+23.5			
	April 1-15	98.9	99.8	+0.9				34.4	68.0	+33.6			
	April 16-30	98.9	99.8	+0.9	64.3	90.2	+25.9	34.4	68.0	+33.6	15.4	56.6	+41.2
	May 1-15	98.6	99.7	+1.1				28.2	60.9	+32.7			
	May 16-31	98.3	99.7	+1.4	52.1	76.9	+24.8	23.0	53.7	+30.7	6.0	37.4	+31.4
	June 1-15	97.3	99.2	+1.9				18.0	40.5	+22.5			
	June 16-30	95.6	98.7	+3.1				13.7	31.2	+17.5	1.4	12.6	+11.2
	July 1-15	93.1	98.1	+5.0				8.9	20.4	+11.5			
	July 16-31	91.4	94.7	+3.3				6.3	11.8	+5.5	0.2	0.8	+0.6
	August	90.5	87.5	-3.0				5.1	3.0	-2.1			
	September	91.4	78.6	-12.8				6.3	1.3	-5.0			
Dry	October	92.2	53.2	-39.0				7.7	0.0	-7.7			
	November	97.3	67.4	-29.9				18.0	0.1	-17.9			
	December	98.6	89.7	-8.9				28.2	4.0	-24.2			
	January	98.7	96.4	-2.3				31.2	15.8	-15.4			
	February	98.4	99.1	+0.7	54.6	64.3	+9.7	25.6	37.4	+11.8			
	Mar 1-15	98.4	99.4	+1.0				25.6	43.7	+18.1			
	Mar 16-31	98.4	99.5	+1.1	54.6	71.3	+16.7	25.6	46.9	+21.3			
	April 1-15	98.3	99.7	+1.4				23.0	40.5	+17.5			
	April 16-30	98.1	99.1	+1.0	49.7	64.3	+14.6	20.4	37.4	+17.0	4.4	18.4	+14.0
	May 1-15	96.4	98.9	+2.5				15.8	34.4	+18.6			
	May 16-31	95.6	98.7	+3.1	43.2	59.9	+16.7	13.7	31.2	+17.5	1.4	12.6	+11.2
	June 1-15	93.9	97.3	+3.4				10.1	18.0	+7.9			
	June 16-30	93.1	93.1	0.0				8.9	8.9	0.0	0.2	0.2	0.0
	July 1-15	91.4	85.2	-6.2				6.3	2.4	-3.9			
	July 16-31	89.7	71.9	-17.8				4.0	0.4	-3.6	0.0	0.0	0.0

	August	87.5	57.4	-30.1				3.0	0.0	-3.0			
	September	89.7	51.1	-38.6				4.0	0.0	-4.0			
CD	October	89.7	45.1	-44.6				4.0	0.0	-4.0			
	November	93.9	51.1	-42.8				10.1	0.0	-10.1			
	December	95.6	54.5	-41.1				13.7	0.0	-13.7			
	January	98.1	74.1	-24.0				20.4	0.7	-19.7			
	February	95.6	93.1	-2.5	43.2	34.9	-8.3	10.1	8.9	-1.2			
	Mar 1-15	95.6	95.6	0.0				13.7	13.7	0.0			
	Mar 16-31	95.6	98.1	+2.5	43.2	49.7	+6.5	13.7	20.4	+6.7			
	April 1-15	94.7	98.1	+3.4				11.8	20.4	+8.6			
	April 16-30	94.7	97.3	+2.6	41.0	47.6	+6.6	11.8	18.0	+6.2	0.8	3.1	+2.3
	May 1-15	93.1	95.6	+2.5				8.9	13.7	+4.8			
	May 16-31	92.2	93.9	+1.7	33.6	38.9	+5.3	7.7	10.1	+2.4	0.0	0.4	+0.4
	June 1-15	85.2	89.7	+4.5				5.1	4.0	-1.1			
	June 16-30	87.5	80.8	-6.7				3.0	1.6	-1.4	0.0	0.0	0.0
	July 1-15	85.2	69.6	-15.6				2.4	0.1	-2.3			
	July 16-31	83.0	60.2	-22.8				2.0	0.0	-2.0	0.0	0.0	0.0
	August	80.8	49.1	-31.7				1.6	0.0	-1.6			
	September	83.0	44.1	-38.9				2.0	0.0	-2.0			

5.2.3 Effects of Diverting Flows

Diversion of flows to storage at Agency Lake Ranch are not likely to negatively affect endangered suckers in UKL because flow diversion occurs during the winter and spring when inflows exceed the flood control levels and water would be spilled at Link River Dam.

Diversion of flows from the Klamath River (Lake Ewauna to Keno Dam) are not likely to have a negative effect on suckers because water levels and resulting habitat remain fairly constant year round regardless of Project operation.

The following proposed diversion actions may result in dewatering or low flows that may have adverse effects on the suckers, including increased predation, increased risk of poor water quality, crowding fish, reduced food availability, and increased risk of fish kills: flow diversion from Miller Creek below Gerber Reservoir during fall and winter storage; from Miller Creek below Miller Creek Dam during the delivery period; from Lost River below Clear Lake to Malone Dam during fall and winter storage; from Lost River below Malone Dam to Bonanza during the delivery period; from Lost River below Wilson Dam to Tule Lake during the fall and winter diversion period; from Lost River below Anderson-Rose Dam to Tule Lake during the delivery period.

5.2.4 Effects of Storing Water in Lakes/Reservoirs

1. Upper Klamath Lake

Reclamation proposes to store water in Upper Klamath Lake year round with a significant portion of the water stored during October through March. In some water years, storage is significant in April, May, and June. During water storage, UKL levels increase resulting in more shoreline spawning habitat and larval, juvenile, and adult rearing habitat, increased depth in and access to water quality refuge areas, reduced risk of poor water quality related to algae blooms and decay cycles and ice-cover conditions, and reduced risk of summer and winter fish kills. Therefore, these conditions would be beneficial for the survival of all sucker life stages.

2. Clear Lake and Gerber Reservoir

Reclamation proposes to store water in Clear Lake and Gerber Reservoir generally from October through April and deliver from storage from April through September. Since quantitative data is not available to describe the environmental baseline, Reclamation cannot conduct the same rigorous quantitative effects analysis as done for Upper Klamath Lake.

The proposed storage action results in increased volume and surface area in Clear Lake and Gerber Reservoir. This action is beneficial for the lake dwelling suckers because it increases habitat for all life stages and reduces the potential risk of winterkill during ice cover periods. Increased habitat potentially decreases competition with other fish for food and space, fish and bird predation, and disease potentially resulting in better health and survival of endangered suckers.

5.2.5 Effects of Water Delivery

Water delivery for Project purposes includes both 1) delivery of water from Upper Klamath Lake storage; and 2) diversion of water from impaired inflows.

Under the proposed action, UKL elevations are drawn down to as low as 4137.0 by the end of September as a result of water delivery for Project purposes. UKL elevations begin to recover during October, November, and December but are still less than baseline elevations, which only go as low as 4139-4140, during those corresponding months. Storage of water may be occurring during those months, but elevations are still less than baseline because of the low lake levels at the end of September.

The minimum October elevations resulting from the action are 4139.4 for “above average”, 4139.3 for “below average”, 4137.4 for “dry” years and 4137.2 for “critical dry” years. The difference between the minimum proposed action and baseline elevation is -0.9, -1.0, -2.7, and -2.8 feet for “above average”, “below average”, “dry” and “critical dry” years respectively. Average October elevations are 4139.9 (above average), 4139.7 (below average), 4138.0 (dry) and 4137.2 (critical dry). The difference between the average proposed action and baseline elevation is -0.8, -0.9, -2.3, and -2.8 feet for “above average”, “below average”, “dry”, and “critical dry” years respectively. Overall, the October elevations resulting from the action are substantially lower than those for the baseline resulting in an unquantified increased risk of achieving harmfully low dissolved oxygen and high ammonia conditions because of lower dilution, higher re-suspension of sediments, and lower volume to sediment surface area. Poor water quality may lead to higher risk of fish die-offs and lower reproductive success. With a higher frequency and magnitude of fish kills, sucker populations may decline. Without adequate adult survival and reproduction, decline of UKL populations may occur due to a reduction in individuals of sufficient age to spawn, which is essential for long-term survival of the species.

Adult sucker habitat (open water areas) resulting from the action ranges from 45.1 percent for “critical dry” years to 89.5 percent for “above average” years in October (Table 5.5). The difference between the average proposed action and baseline adult habitat is -6.1, -11.7, -39.0, and -44.6 percent for “above average”, “below average”, “dry” and “critical dry” years respectively. There is substantially less adult habitat for the action in “dry” and “critical dry” years than the baseline. Adult suckers may be crowded during these year types potentially increasing the risk of disease and fish die-offs.

The area of shoreline emergent vegetation habitat resulting from the proposed action is small during all year types ranging from 0 to 3.0 percent. The difference between the proposed action and baseline shoreline emergent habitat is -10.7, -9.8, -7.7, and -4.0 percent for “above average”, “below average”, “dry”, and “critical dry” years respectively. However, this habitat is less important for age 0 juvenile suckers because this life stage also occupies open water habitat and unvegetated shoreline areas. Therefore, October lake levels for the action are not likely to have an adverse effect on age 0 suckers.

In November, minimum elevations are 4139.7 for “above average” and “below average” years, 4137.8 for “dry” years and 4137.8 for “critical dry” years. The difference between the minimum proposed action and baseline elevation is -0.8, -0.8, -2.7, and -2.7 for “above average”, “below average”, “dry” and “critical dry” years respectively. Average November elevations are 4140.0, 4139.9, 4139.0, and 4137.8 for the four water year types. They are 1.1, 1.1, 1.9, and 2.7 feet lower than the average November baseline elevations for “above average”, “below average”, “dry” and “critical dry” years respectively. In November, lake elevation generally increases and water temperatures and algae growth decrease compared to October. Average lake elevations resulting from the proposed action are lower during all water year types than the baseline. However, water quality and habitat are generally adequate for endangered suckers during this period.

Algae growth is relatively low in the winter compared to other seasons. Most fish are relatively inactive due to low

water temperatures, and water quality conditions are generally good. However, harmfully and/or lethal low dissolved oxygen levels can occur during ice-cover conditions. Ice-cover conditions frequently occur from December through February, lasting from a few weeks to several months. The depletion rate of dissolved oxygen in the water column increases as the depth/volume of the lake decreases because the lower volume holds less oxygen relative to the biological oxygen demand of the sediments. Ice-cover also eliminates wind-induced mixing that adds oxygen to water and prevents stratification. With ice-cover conditions stratification occurs and near bottom water may become anoxic (no oxygen) leading to release of high levels of ammonia from the sediments into the water column. When ice cover breaks up, the high ammonia mixes throughout the water column having a negative effect on sucker growth and survival. There is a higher, although unquantified, risk of poor water quality at lower lake elevations compared to higher lake elevations. Water quality conditions in Upper Klamath Lake are usually favorable during October and November because of cooler water temperatures and declining algae growth. However, algae bloom and decay cycles can continue during these months resulting in potentially harmful and/or lethal water quality conditions.

The minimum elevations for December resulting from the proposed action are 4140.5 (above average), 4140.1 (below average), 4138.1 (dry), and 4137.9 (critical dry). The difference between minimum proposed action and baseline elevation is -0.3, -0.6, -2.5, and -2.7 feet for “above average”, “below average”, “dry” and “critical dry” years respectively. The average December elevations resulting from the proposed action for “above average” and “below average” years (4140.5) are 0.9 feet lower than baseline elevations for “above average” and 1.0 foot lower for “below average” years (4140.6). Average “dry” year (4140.0) and “critical dry” year (4138.1) elevations are 1.3 and 2.6 feet lower than average baseline elevations respectively. The proposed action minimum and average December elevations are slightly less than the baseline elevations during “above average” and “below average” years and substantially less in “dry” and “critical dry” years. There is an increased risk of harmful and/or lethal water quality during ice-cover conditions for the action compared to the baseline particularly for the “dry” and “critical dry” years. The frequency and magnitude of winterkill events may increase resulting in a decline in sucker populations and reduction in reproduction.

Winterkill is the major concern for January. The minimum elevations for January resulting from the proposed action are 4141.0 for “above average” and “below average” years, 4139.1 for “dry” years, and 4139.0 for “critical dry” years. The difference between minimum proposed action and baseline elevation is 0.2, 0.1, -1.6, and -1.9 feet for “above average”, “below average”, “dry”, and “critical dry” years respectively. The average January elevations resulting from the proposed action for “above average” and “below average” are 4141.0, 4140.8 for “dry” years, and 4139.3 for “critical dry” years. The difference between average proposed action and baseline elevation is -0.6 for “above average”, “below average”, and “dry” years, and -1.7 feet for “critical dry” years. Like December, there is an increased risk of harmful and/or lethal water quality during ice-cover events.

Historically, many shoreline springs provided important spawning areas for Lost River and shortnose suckers. Barkley Springs, Odessa Springs, Harriman Springs, and several others in Upper Klamath Lake have been altered and are currently not being used. Sucker spawning currently occurs at a few shoreline areas including Sucker Springs, Silver Building Springs, Ouxy Springs, Cinder Flat and Boulder Springs along the east side of the lake. Shoreline spawning occurs from late February through early-May with a peak in March or April (Perkins et al. 2000). Coarse substrate areas at Sucker Springs, Silver Building Springs, Ouxy Springs and Cinder Flat become available for spawning (one foot deep or greater) at elevations of approximately 4140.0, 4139, 4140.5, and 4138 respectively. Table 5.2 presents a summary of the shoreline spawning habitat-lake elevation relationship.

Minimum Upper Klamath Lake elevations resulting from the action for February (which correspond to the approximate starting date of the shoreline spawning season) are 4140.3, 4141.7, 4141.1, and 4139.4 for “above average”, “below average”, “dry” and “critical dry” years respectively. The difference between February minimum proposed action and baseline elevation is -0.6, 0.6, 0.2, and -1.3 feet for “above average”, “below average”, “dry” and “critical dry” years respectively. Average February elevations are 0.5 feet lower for “above average” (4141.6), 0.3 feet higher for “below average” (4141.7), 0.4 feet higher for “dry” (4141.6) and 0.3 feet lower for “critical dry” years (4140.4). Shoreline spawning habitat ranges from 34.9 to 64.3 percent for the proposed action compared to 43.2 to 76.9 percent for the baseline. The percent difference in shoreline spawning habitat is -12.6, 4.7, 9.7 and -8.3 between the proposed action and baseline for “above average”, “below average”, “dry” and “critical dry” years respectively. February elevations resulting from the proposed action provide less shoreline spawning habitat during “above average” and “critical dry” years and more habitat during “below average” and “dry” years. Reduced habitat area for “critical dry” years may adversely affect shoreline spawning success potentially resulting in smaller-sized

year classes.

Lake elevations usually increase in March resulting in greater inundation of shoreline spawning areas. Minimum Upper Klamath Lake elevations resulting from the proposed action for March are 4142.3 for “above average” and “below average”, 4141.2 for “dry” years and 4139.9 for “critical dry” years. These minimum elevations are 0.9 feet higher for “above average”, 1.0 foot higher for “below average”, and 0.2 feet higher for “dry” years than baseline minimum elevations. For “critical dry” years, the minimum elevation is 0.7 feet lower than the baseline minimum elevation. Average March elevations for the proposed action are 4142.3 for “above average” and “below average” years, 4141.9 for “dry”, and 4141.0 for “critical dry” water year types. The difference between the March average proposed action and baseline elevation is -0.1, 0.7, 0.7, and 0.3 feet for the four water year types respectively. Shoreline spawning habitat ranges from 49.7 to 83.6 percent for the proposed action and 43.2 to 86.9 percent for the baseline. The percent difference between the proposed action and baseline is -3.3, 19.3, 16.7, and 6.5 for “above average”, “below average”, “dry”, and “critical dry” years respectively. Average March elevations under the proposed action provide similar shoreline spawning habitat for “above average” years and more for “below average”, “dry”, and “critical dry” years than the baseline.

Minimum Upper Klamath Lake elevations during April resulting from the proposed action are 4142.3 for “above average” and “below average” years, 4140.6 for “dry” years and 4140.0 for “critical dry” years. The minimum April elevations resulting from the proposed action are 0.5 feet higher for “above average”, 1.2 feet higher for “below average”, -0.2 feet for “dry” and -0.6 feet for “critical dry” years than baseline minimum elevations. Average April elevations for the proposed action are 0.2 feet higher for “above average” (4142.6), 1.0 foot higher for “below average” (4142.5), 0.6 feet higher for “dry” years (4141.6) and 0.3 feet higher for “critical dry” years (4140.9) than baseline elevations. Shoreline spawning habitat ranges from 47.6 to 91.1 percent for the proposed action and 41.0 to 86.9 percent for baseline. The difference in habitat between the proposed action and baseline is 4.2, 25.9, 14.6, and 6.6 percent for “above average”, “below average”, “dry”, and “critical dry” years respectively. Overall, the average April elevations resulting from the proposed action provide slightly more shoreline spawning habitat for “above average” and “critical dry” years and substantially more for “below average” and “dry” years” compared to the baseline potentially resulting in increased spawning success and larger-sized year classes.

Larval suckers produced at lake shoreline and tributary stream spawning areas may be present from March through July (Simon et al. 2000). This life stage appears to be dependent on shallow shoreline areas; particularly those vegetated with emergent wetland plants (Cooperman and Markle 2000). This vegetation provides hiding cover from predation by fathead minnows and other fish, protection from high velocities and turbulence caused by wind and wave action, and complex structure for food items including zooplankton, macro-invertebrates and periphyton (Klamath Tribes 1996).

Emergent vegetation along the lower Williamson River may play an important role in larval sucker survival even though the amount of emergent vegetation habitat is relatively small because of diking and draining of shoreline wetlands. This habitat provides food resources for emigrating larvae that need to eat because their yolk is generally depleted and as protection from predation. Most sucker larvae use these habitats for a short period as they migrate to the lake. Larval emigration can begin during April in the Williamson River. However, most emigration occurs during May and June.

The emergent vegetation habitat-to-lake elevation relationship for the lower Williamson River and major rearing sites in Upper Klamath Lake is shown in Table 5.3. The emergent vegetation habitat begins at about 4140.5 in the lower Williamson and 4139.5 in Upper Klamath Lake and increases at higher elevations.

Minimum May elevations resulting from the proposed action are 4142.0 for “above average” and “below average” years, 4140.6 for “dry” years and 4139.5 for “critical dry” years. These minimum elevations are 0.4 feet higher for “above average”, 1.2 feet higher for “below average”, 0.1 feet lower for “dry” and 0.7 feet lower for “critical dry” years than the minimum lake levels for baseline conditions. On average, May proposed action elevations are 0.5 feet higher for “above average” (4142.6), 1.0 foot higher for “below average” (4142.1), 0.7 feet higher for “dry” (4141.4), and 0.2 feet higher for “critical dry” years (4140.5) than average baseline May elevations.

Emergent vegetation habitat in the lower Williamson River during May ranges from 0.4 to 61.8 percent for the proposed action and 0 to 37.4 percent for baseline. The percent difference in habitat between the proposed action

and the baseline is 24.4, 31.4, 11.2, and 0.4 for “above average”, “below average”, “dry” and “critical dry” years respectively. May emergent vegetation habitat in Upper Klamath Lake at Goose Bay and Tulana range from 10.1 to 71.7 percent for the proposed action and 7.7 to 53.7 percent for the baseline. The percent difference in Upper Klamath Lake emergent habitat between the proposed action and baseline is 18.0, 30.7, 17.5, and 2.4 for “above average”, “below average”, “dry”, and “critical dry” years respectively. The May elevations resulting from the action provide substantially more emergent vegetation habitat in the lower Williamson River and Upper Klamath Lake than baseline conditions for all water year types. This may result in higher survival of sucker larvae and larger-sized year classes during all water year types compared to the baseline.

High April and May lake elevations (near full pool) relate to later initiation of *Aphanizomenon* blooms and lower bloom magnitude (Kann 1998). Several potential processes explain water quality benefits of high lake levels in the spring. By maintaining higher lake levels in April and May, less light reaches the bottom where resting stage algae (akinetes) germinate to start the bloom cycle possibly delaying the bloom (Barbiero and Kann 1994). Also, higher lake levels/volume can reduce the rate of lake warming that leads to algae bloom initiation (Welch et al. 2001). Blooms have started as early as mid-May and as late as early July (Wood et al. 1996, Kann 1998). The greater the depth during the growing season, the less frequent contact of algae cells with light, potentially decreasing the magnitude of the bloom events (Welch et al. 2001). In addition, water inflows from tributaries and other sources can have higher concentrations of bloom stimulating nutrients than the lake water (Kann and Walker 2000). Since these inflows are frequently at yearly high volumes, maintaining higher lake levels would have a dilution effect, possibly resulting in a bloom of lower magnitude (Klamath Tribes 1995). Later occurring blooms decrease the probability that larval suckers will experience harmful water quality conditions caused by algal blooms. The pH values during this time period have approached or exceeded lethal levels for larval and early juvenile Lost River and shortnose suckers determined in laboratory bioassays (Saiki et al. 1999). There is a lower risk of initiating an early and higher magnitude bloom under the proposed action, when compared to the baseline in all water year types because lake levels are higher in April and May.

The proposed action minimum elevations for June are 4141.3 for “above average” and “below average” years, 4139.5 for “dry” years, and 4138.8 for “critical dry” years. These elevations are 0.3 feet higher for “above average”, 0.9 feet higher for “below average”, 0.8 feet lower for “dry” years and 0.9 feet lower for “critical dry” years than baseline levels. On average, the proposed action June elevations of 4142.3 (above average), 4141.4 (below average), 4140.4 (dry), and 4139.6 (critical) are 0.9 feet higher than baseline for “above average”, 0.7 feet higher for “below average” years, the same for “dry” years, and 0.2 feet higher for “critical dry” years. Since lake levels are generally higher for the proposed action than the baseline during “above average” and “below average” years, there is a lower risk of large-sized blue-green algae blooms and associated poor water quality.

Larval emigration continues in the Williamson River during June and shoreline habitat in Upper Klamath Lake becomes more important as more larval suckers enter the lake. June emergent vegetation habitat in the lower Williamson for “above average”, “below average”, “dry”, and “critical dry” years is 46.6, 12.6, 0.2, and 0 percent respectively for the proposed action. Emergent habitat for the baseline is 12.6, 1.4, 0.2, and 0 percent for “above average”, “below average”, “dry” and “critical dry” water year types respectively. The percent difference is 34.0 for “above average”, 11.2 for “below average”, 0 for “dry”, and 0 for “critical dry” years. Emergent vegetation habitat in Upper Klamath Lake ranges from 1.6 to 60.9 percent for the proposed action and 0 to 31.2 percent for baseline conditions. The percent difference between the proposed action and baseline Upper Klamath Lake emergent habitat is 29.7, 17.5, 0, and -1.4 for “above average”, “below average”, “dry” and “critical dry” years respectively. The proposed action results in greater depths and more inundation of emergent vegetation habitat than under baseline condition for “above average” and “below average” years and similar habitat conditions for “dry” and “critical dry” years.

Because there is generally more emergent vegetation habitat available for the proposed action than the baseline, larval sucker survival may be higher and year classes larger-sized.

From July through September, *Aphanizomenon* blooms are a dominant factor affecting Upper Klamath Lake water quality. Maintaining high lake levels, generally above 4140, may increase the probability of smaller-sized algae blooms and associated pH and dissolved oxygen levels that are generally lower with less daily fluctuation than would occur during larger blooms. Higher lake levels may result in lower light availability, which lowers growth rate and therefore limits the actual size of the algae bloom. Most photosynthesis is limited to the top meter of the water column during a bloom (Kann 1998). During a mixed situation (which frequently occurs), algae spend a

portion of the time at deeper depths where respiration exceeds photosynthesis, retarding growth. The deeper the water column the greater the dilution effect on algae biomass. Increased lake level dilutes total phosphorus (an important plant nutrient) entering the water column from the sediments, which in turn limits the maximum possible size of the algae blooms (Klamath Tribes 1995). These two direct effects of lake levels are enhanced by the positive feedback cycle. In this cycle, algal growth increased pH and thereby stimulates the release of phosphorus from the sediments, creating the potential for algae to reach even higher biomass. Increased lake levels inhibit this cycle through each of the two direct pathways.

The minimum July elevations resulting from the proposed action are 4140.6 for “above average” and “below average” years, 4138.6 for “dry” years and 4138.1 for “critical dry” years. These elevations are 0.4 feet higher than baseline for “above average” years, 0.6 feet higher for “below average”, 1.3 feet lower for “dry” years, and 1.6 feet lower for “critical dry” years. The average July elevations are 4141.4, 4140.6, 4139.2, and 4138.5 feet for “above average”, “below average”, “dry” and “critical dry” years respectively. On average, the proposed elevations are 0.8 and 0.4 feet higher than the baseline “above average” and “below average” July elevations respectively, 0.8 feet lower for “dry” years, and 1.2 feet lower for “critical dry” years. The higher July minimum and average elevations resulting from the proposed action during “above average” and “below average” years provide a lower risk of large magnitude algae blooms and associated high pH and high and low dissolved oxygen levels that stress fish than under the baseline conditions. This lower risk is associated with dilution, light limitation, and sediment re-suspension mechanisms. Maintenance of good water quality is important for adequate functioning of one of the primary elements of habitat. For “dry” and “critical dry” years where the proposed action elevations are lower than the baseline there is a higher risk of large-sized algae blooms and poor water quality.

Emergent vegetation habitat ranges from 0 to 31.2 percent under the proposed action and 0.0 to 11.8 percent for baseline in July. The percent difference in Upper Klamath Lake emergent habitat between the proposed action and baseline is 19.4 for “above average”, 5.5 for “below average”, -3.6 for “dry”, and -2.0 for “critical dry” years. Although there is much less emergent habitat available in July than during May and June under both the proposed action and baseline conditions, suckers are less dependent on this habitat for rearing than in previous months. Not only have larval suckers grown to a larger size where they are less vulnerable to predation but also they occupy a wider range of habitats including non-vegetated shoreline areas and open water areas (Simon et al. 2000).

Adult suckers generally occupy open water habitat greater than three feet deep except during the spawning season (Peck 2000). Further, they appear to be mostly concentrated in the northern portion of Upper Klamath Lake particularly during the summer and fall. The open water habitat-to-lake elevation relationship is displayed in Table 5.4. Most of the open water habitat for adult suckers is available during the spring and early summer (through July) under the proposed action and baseline conditions.

Blue-green algae blooms and die-offs are a dominant factor affecting UKL water quality during August and September. During algae die-offs low dissolved oxygen and high un-ionized ammonia concentrations can occur resulting in stressful and/or lethal conditions for fish. When the bloom crashes, water column biological oxygen demand increases and at the same time, photosynthetic oxygen production is reduced throughout the water column. At lower elevations, the ratio of lake volume to sediment surface area decreases. As this ratio decreases, the depletion rate of dissolved oxygen in the water column increases because the lower water volume holds less oxygen relative to the BOD of the sediments. It has also been shown that increased re-suspension of sediments that is higher at low lake levels causes more depletion of oxygen and release of ammonia into the water column (Barica 1974). Additionally, during calm meteorological conditions there is an increased risk of poor water quality at low lake levels. During calm periods, anoxic (no oxygen) conditions occur at the lake bottom leading to greater production of ammonia that is subsequently mixed in the water column when winds occur. Low dissolved oxygen conditions also occur near the bottom under calm conditions due to high biological oxygen demand (BOD). When mixing occurs the low dissolved oxygen is spread throughout the water column. Large algae blooms and subsequent crashes occurred during late summer in 1995, 1996, 1997 and 1998 (Perkins et al. 2000, Welch et al. 2001).

Recent information suggests that freshwater inflow areas thought to be sucker refuges when water quality degrades in Upper Klamath Lake are used less frequently than previously suspected (Reclamation 1996). Radio-tagged adult suckers generally concentrated in close proximity to, but not in, freshwater inflow areas before and during periods of poor water quality and sucker die-offs (Peck 2000). These areas are adjacent to Pelican Bay, Williamson River, Wood River and other tributaries and springs. The bottom elevations in these areas range from 4134.0 to 4136.0. Based on adult sucker radio telemetry studies, water depths of three feet and greater are necessary to provide

adequate refuge habitat.

Water quality in these transition areas is generally better than that found elsewhere in the lake, but more variable because of the influence of lake water quality, proximity to bottom sediment, and wind-caused mixing and re-suspension of bottom sediment. Degraded water quality has been monitored in these areas when depths were shallow at elevations below 4139 (< 3 feet deep; Reclamation 1996).

The minimum August elevation for “above average” and “below average” years are 4139.8, 4137.8 for “dry” and 4137.4 for “critical dry” years. These levels are 0.2 feet lower for “above average” and 0.1 feet lower for “below average” years than baseline minimums. For “dry” and “critical dry” year types elevations are 2.0 and 2.2 feet lower than baseline minimum elevations respectively. The average August elevations are 4140.6 for “above average”, 4139.9 for “below average”, 4138.3 for “dry”, and 4137.6 for “critical dry” years. These average elevations are 0.3 feet higher than baseline for “above average”, 0.2 feet lower for “below average”, 1.6 feet lower for “dry”, and 2.0 feet lower for “critical dry” years. Adult sucker habitat ranges from 49.1 to 94.7 percent under the proposed action versus 80.8 to 92.2 percent for baseline. The percent difference between the proposed action and baseline adult habitats is 2.5, -3.0, -30.1 and -31.7 for “above average”, “below average”, “dry” and “critical dry” years respectively. The difference in adult habitat between the proposed action and baseline are relatively small for “above average” and “below average” years. However, there is substantially less adult habitat for the proposed action than the baseline for “dry” and “critical dry” years. This may result in crowding of fish and associated stress and higher risk of disease and fish kills.

Minimum August water depths in water quality refugia areas range from 1.4 (4137.4) to 3.8 feet (4139.8) for the proposed action compared to 3.6-4.0 feet for the baseline. Since water depths for access and habitat in refuge areas are less than 3 feet for “dry” and “critical dry” years, adult suckers may be forced to occupy deeper water areas that have poor water quality increasing the risk of fish kills.

Minimum September elevations are 4139.3 for “above average” years and “below average” years, 4137.2 for “dry” years and 4137.0 for “critical dry” years. The proposed action minimum lake levels are 0.8, 0.8, 2.7, and 2.7 feet lower than baseline minimums for “above average”, “below average”, “dry”, and “critical dry” years respectively. Average September elevations are 4140.6 for “above average” and 4139.5 for “below average”, 4137.8 for “dry”, and 4137.1 for “critical dry” years. These elevations are 0.2 feet higher than the baseline elevations for “above average”, 0.7 feet lower for “below average”, 2.2 feet lower for “dry” and 2.6 feet lower for “critical dry” years. The substantially lower minimum elevations for all water year types and average elevations for “below average”, “dry” and “critical dry” years may increase the risk of achieving harmfully low and/or lethal dissolved oxygen and high un-ionized ammonia conditions. There is a higher risk of fish die-offs. With a higher frequency and magnitude of fish kills sucker populations may decline. Without adequate adult survival and reproduction, decline of UKL populations may occur due to a reduction in individuals of sufficient age to spawn, which are essential for long-term survival of the species.

The September adult open water rearing habitat for the action is 94.7, 78.6, 51.1, and 44.1 percent for “above average”, “below average”, “dry” and “critical dry” years respectively. The amount of adult rearing habitat is similar between the proposed action and baseline for “above average”, 12.8 percent less for “below average”, 38.6 percent less for “dry” and 38.9 percent less for “critical dry” years. There is substantially less adult rearing habitat for the proposed action than the baseline for “dry” and “critical dry” years. This may result in crowding of fish and associated stress leading to increased risk of disease and fish kills.

Minimum September water depths in water quality refugia areas range from 1.0 to 3.3 feet with the proposed action and 3.7 to 4.1 feet for the baseline. Access to and amount of water quality refugia habitat available as a result of the proposed action may adversely affect adult suckers during “dry” and “critical dry” years because water depths are less than three feet. Fish may be relegated to deeper areas that may have poor water quality increasing the risk of fish kills.

In summary, the effect of delivery from storage results in lowering of lake levels, reducing the amount of habitat available of shoreline spawning, larval and juvenile rearing in shoreline emergent vegetation, the amount of adult open water rearing habitat and depth in and access to water quality refuge areas. Lower lake levels also increase the probability of larger algae blooms and poor water quality that may be stressful and/or lethal to suckers. However,

elevations resulting from the proposed action start out higher during the spring than the baseline providing more shoreline spawning habitat, emergent vegetation habitat and lower risk of early and large-sized algae blooms and associated poor water quality. During the summer, fall, and winter elevations for the proposed action are generally lower than the baseline reducing rearing habitat and increasing the risk of poor water quality during algae bloom and decay cycles. With shallow depths in water quality refuge areas, adult suckers may not use these areas remaining in areas with poor water quality where they are susceptible to disease and fish kills. Lower elevations resulting from the proposed action may increase the risk of winterkill. Overall, the negative effects of lower elevations during summer, fall and winter are likely to have a greater effect on sucker survival than the positive effects of higher spring elevations. Although spawning success and juvenile survival may start out higher, the potentially adverse conditions associated with the lower lake levels during other seasons may lead to higher mortality of suckers particularly adults.

With the proposed action, sucker populations may not be sufficiently large to withstand stress and mortality associated with other contemporaneous events such as droughts, disease, predation, adverse water quality, high flows and other factors and random events that affect survival. Populations may lose genetic diversity as a result of significant fish kill events. The proposed action may not support diverse age class structures that are needed to ensure survival during events that might be age- or size-specific, such as have been suspected during UKL die-offs. Having sufficient numbers of older and larger fish is crucial because reproductive potential is size dependent.

5.2.6 Clear Lake and Gerber Reservoir

Flow diversion from Clear Lake and Gerber Reservoir are likely to have a detrimental effect on endangered suckers in the Lost River and Miller Creek respectively. Flows in the Upper Lost River (Clear Lake to Bonanza) and Miller Creek are very low during the fall and winter. Juvenile and adult suckers health and survival may be reduced because of stranding, increased predation, potentially harmful water quality conditions, increased stress from crowding and lack of food, higher incidence of disease, and fish kills.

During the spring and summer, Miller Creek below Miller Creek Diversion Dam is reduced to very low flows resulting in poor habitat conditions for suckers.

In the Lost River below Bonanza to Wilson Dam, flow diversions at Clear Lake and Gerber Reservoir are not likely to have a negative effect on suckers and their habitat because unregulated streams, groundwater springs and runoff maintain adequate habitat and flows in the fall and winter. Adequate flow and habitat conditions are likely to occur during spring and summer.

Water delivery from storage during the spring and summer results in lower lake levels, volume and surface area in Clear Lake and Gerber Reservoir. The effects of the delivery results in a reduction in shoreline habitat occupied by larval and age 0 juvenile suckers and open water habitat for juvenile and adult suckers. This reduction of habitat may increase competition with other fish for food and space, fish and bird predation, and disease potentially resulting in stress and lower survival of endangered suckers.

During years when the surface area of Clear Lake is less than 4524 from February through April, access to spawning areas in Willow Creek is blocked. Low stream flows occur in dry years restricting passage to upstream spawning areas. Reproduction may be unsuccessful or extremely low resulting in a small year class or no year class.

Since a large percentage of the lake has a bottom elevation of about 4520 (most of the east lobe), lowering the lake below 4524 substantially reduces juvenile and adult habitat. As water levels drop suckers likely move to the deeper west lobe where fish become more concentrated and may be adversely affected by increased competition, predation, and disease.

In 1992, when Clear Lake elevation reached a minimum of 4519.4 in October, suckers showed signs of stress including low body weight, poor development of reproductive organs, reduced juvenile growth rates, and high incidence of external parasites and lamprey infestation (Reclamation 1994). Fish condition at higher lake levels in 1993-1995 were improved with increased body weight and fewer external parasites and lamprey wounds (Scopettone et. al. 1995).

Lower lake levels may also result in degraded water quality including higher water temperatures and lower dissolved oxygen levels. However, water quality monitoring over a wide range of lake levels and years documented water quality conditions that were adequate for sucker survival (Reclamation 2000). The major concern for harmful and/or lethal water quality conditions is associated with winter ice cover periods. At low lake levels there is an increased risk of low dissolved oxygen and potential winterkill during ice cover conditions. During the winter of 1992-1993, Clear Lake was ice covered for several months at an elevation of about 4519.5. In that year dissolved oxygen concentrations remained at adequate levels for sucker survival (>4 mg/l; Reclamation 1994).

Because of the relatively low recharge rate in Clear Lake, lake levels may remain at relatively low levels for several years. These conditions may adversely affect suckers because of crowding and the negative impacts associated with it including: increases in stress, competition for food and space, predation, and disease.

Extended drought may result in complete or nearly complete desiccation of Clear Lake. However, model simulations demonstrate that if the surface elevation of Clear Lake is at least 4521 on October 1, it is unlikely that the lake will drop below 4519 in the following year. Therefore, delivery of water that results in a lake level of less than 4521 before October 1 may adversely affect survival of suckers in Clear Lake.

During years when the surface area of Gerber Reservoir is less than about 4805 from February through April, access to spawning areas in Barnes Valley and Ben Hall creeks is restricted due to a blockage at the mouth of the creeks. Also, in dry years these streams typically have very low flows that may not be adequate for upstream passage of spawning adults. Reproduction may be unsuccessful or extremely low resulting in a small year class or no year class.

During dry years when minimum elevations go down to 4800, the surface area shrinks to about 750 acres, reducing sucker habitat to less than a third of the full reservoir area. When juvenile and adult rearing habitat shrinks to low amounts suckers are likely stressed by poor water quality (high temperature, low dissolved oxygen), increased competition, and increased incidence of disease, parasites, and predators. Effects of low lake levels on larval and juvenile suckers is likely to be even greater than adults since they have lower food reserves, higher metabolism, lower mobility, and are more vulnerable to predators.

Lower lake levels may also result in degraded water quality including higher water temperatures, higher pH values and lower dissolved oxygen levels. However, water quality monitoring over a wide range of lake levels and years documented water quality conditions that were generally adequate for sucker survival except in 1992 (Reclamation 2000). In that year, Gerber Reservoir dropped to a minimum elevation of 4796.4, and low dissolved oxygen concentrations were documented during the summer. While DO levels in the upper water column were adequate for suckers (4-6 mg/l) from May through mid-September, concentrations near the bottom were consistently below 4 mg/l and reached a low of 1.1 in June. Also, mechanical aeration was used to enhance oxygen levels near the dam.

Suckers in the reservoir at the time showed signs of stress including low body weight, poor development of reproductive organs, and reduced juvenile growth rates (Reclamation 2000). Fish were also frequently observed breaching the surface of the water. This behavior has not been observed in other years.

A major concern for harmful and/or lethal water quality conditions in Gerber Reservoir is associated with winter ice cover periods. At low lake levels there is an increased risk of low dissolved oxygen and potential winterkill during ice cover conditions. During the winter of 1992-1993, Gerber Reservoir was ice covered for several months at an elevation of 4796.5. Winter dissolved oxygen levels in 1992-1993 remained low, frequently below 4 mg/l and as low as 1.5 mg/l (Reclamation 2000).

Specific effects of droughts on suckers in Gerber Reservoir are unknown, but because of the relatively low recharge rate, lake levels may remain at relatively low levels for several years. These conditions may adversely affect suckers because of crowding and the negative impacts associated with it including: increases in stress, competition for food and space, predation, and disease.

5.2.7 Effects of Other Proposed Actions

Flow diversion in the Lost River at Wilson Dam (to the Klamath River) during the fall and winter may negatively affect suckers and their habitat in the Lost River downstream of the dam to Tule Lake. Low flows may lead to stress from crowding, lack of food and cover, increased predation and disease, and increased risk of poor water quality and fish kills.

At Anderson-Rose Dam flow diversion during the irrigation delivery period may result in poor access for spawning fish from Tule Lake to spawning areas below the dam, inadequate flows for sucker spawning, egg incubation, larval rearing and emigration, and summer and fall juvenile rearing habitat.

Some delivery of stored water in UKL occurs during the winter in the Lower Klamath Lake area. This action may have a negative effect on suckers in Upper Klamath Lake because lake levels are generally lower than the baseline increasing the risk of winterkill associated with poor water quality during ice-cover events.

Delivery of stored water from Clear Lake and Gerber Reservoir and natural flows increases the amount and quality of habitat in the Lost River from Clear Lake Dam to Wilson Dam because flows are generally higher than the baseline. Delivery of stored water from Upper Klamath Lake through Lake Ewauna and the Lost River Diversion Canal into the Lost River at Station 48 increases the quantity and quality of habitat from Wilson Dam to Anderson-Rose Dam.

A major effect of Project operation is the loss of large numbers of larvae, juvenile and adult suckers through entrainment at the A-Canal. Reclamation's proposed action includes screening the A-Canal by July 2003 to minimize take associated with project operations. The screen is expected to eliminate all entrainment of adults and juveniles (greater than 50 mm) and reduce entrainment of larval and early juvenile suckers. Reclamation completed an entrainment reduction project at Agency Lake Ranch in 2001. A screen is also to be installed at the outlet of Clear Lake in 2002. Entrainment reduction into the A-Canal, Clear Lake and Agency Lake Ranch should improve the survival rate of suckers particularly juveniles. This may lead to increases in individual year class and overall population size in UKL and Clear Lake.

Entrainment of larval, juvenile, and adult suckers at other project facilities including Gerber Reservoir, Miller Creek, Tule Lake, and diversions in the Lost River and Klamath River may occur as a result of the proposed action. However, Reclamation proposes to prepare a multi-year plan to design and install screens at other facilities.

Another major effect is the lack of adequate passage facilities at Link River Dam to allow suckers to move into areas of preferred habitat or to spawning areas in or above Upper Klamath Lake. Reclamation's proposed action includes installation of a new passage facility at Link River Dam by July 2006. Adequate fish passage will increase the access to Upper Klamath Lake by fish entrained through Link River Dam and those occupying downstream habitat seeking to migrate to spawning areas in Upper Klamath Lake or tributaries to Upper Klamath Lake. This may lead to a larger and more genetically diverse sucker populations.

5.2.8 Summary of Effects Analysis

When compared to the environmental baseline condition, the proposed action is likely to have the following effects on endangered suckers:

1. Diversion of flows to storage at Agency Lake Ranch are not likely to negatively affect endangered suckers in UKL because flow diversion occurs during the winter and spring when inflows exceed the flood control levels and water would be spilled at Link River Dam.
2. Diversion of flows from the Klamath River (Lake Ewauna to Keno Dam) are not likely to have a negative effect on suckers because water levels and resulting habitat remain fairly constant year round regardless of Project operation.
3. The following proposed diversion actions may result in dewatering or low flows that may have adverse effects on

the suckers such as increased predation, increased risk of poor water quality, crowding fish, reduced food availability, and increased risk of fish kills. Proposed diversions include: flow diversion from Miller Creek below Gerber Reservoir during fall and winter storage; from Miller Creek below Miller Creek Dam during the delivery period; from Lost River below Clear Lake to Malone Dam during fall and winter storage; from Lost River below Malone Dam to Bonanza during the delivery period; from Lost River below Wilson Dam to Tule Lake during the fall and winter diversion period; from Lost River below Anderson-Rose Dam to Tule Lake during the delivery period.

4. Storing water increases lake levels resulting in more shoreline spawning habitat in UKL, increase larval, juvenile, and adult rearing habitat in all reservoirs, increases water quality refuge habitat in UKL, reduces risk of winterkill in all reservoirs, and reduces risk of poor water quality related to algae bloom and decay cycles in UKL. These conditions would be beneficial for the survival of all sucker life stages.

5. Delivering water from storage and natural flows lowers lake levels, results in less shoreline spawning habitat in UKL; reduces larval, juvenile and adult rearing habitat in all reservoirs; decreases habitat area in water quality refuge areas in UKL; increases the frequency and magnitude of potentially harmful water quality conditions related to algae bloom and decay cycles in UKL; and increases the risk of winterkill in all reservoirs.

6. Delivering water from storage increases flow in Miller Creek and Lost River would provide more rearing habitat and reducing the risk of poor water quality associated with algae and aquatic plant growth.

7. Because UKL levels would be generally higher during the late winter and spring than the baseline, there is more shoreline spawn and larval rearing habitat potentially increasing spawning success and resulting in larger-sized year age classes.

8. Because UKL levels would be generally lower during the summer and fall than the baseline there is less juvenile and adult rearing habitat, and water quality refuge habitat. There is also a higher risk of poor water quality during algae bloom and decay cycles that may negatively affect juvenile and adult sucker health and survival.

9. Since UKL would be generally lower during the winter than the baseline there is a higher risk of winterkill during ice-cover conditions that may have a detrimental effect on juvenile and adult health and survival.

10. The proposed action would reduce entrainment into the A-Canal, Agency Lake Ranch, and Clear Lake potentially increasing survival of juvenile and adult suckers and overall population size. Entrainment at other project facilities would occur negatively affecting survival of all sucker life stages.

11. The proposed action would provide adequate passage of suckers at Link River Dam into areas of preferred habitat or to spawning areas potentially increasing their survival and reproductive success. Passage would be blocked at other project facilities including Clear Lake, Gerber Reservoir, Malone, Wilson and Anderson-Rose dams.

5.3 EFFECTS ON COHO SALMON

5.3.1 Mainstem Klamath River

This section provides an analysis of the effects of the proposed action compared to the environmental baseline for coho salmon. Flows in the mainstem Klamath River downstream from Iron Gate Dam will be affected by changes in flows at Iron Gate Dam. This is illustrated by comparing the flows in the Klamath River downstream from Iron Gate Dam with the proposed action against baseline conditions (Tables 5.6 and 5.7). The analysis of effects is based in large part on habitat-discharge relationships presented in Table 5.8 and Figure 1. Reclamation assumed that the preliminary habitat versus discharge relationships for the various anadromous fish species developed as part of the Hardy Phase II study as discussed in Chapter 4.0 were appropriate for use in this BA.

Operations under the proposed action would affect the amount of suitable habitat available to coho salmon in the

Klamath River mainstem. The relationship between changes in habitat quantity and quality, and the status and trends of fish and wildlife populations has been the subject of extensive scientific research and publication (although not specific to the Klamath Basin), and the assumptions underlying our assessment are consistent with this extensive scientific base of knowledge. For detailed discussions of the relationship between habitat variables and the status of salmon populations, readers should refer to the work of FEMAT (USDA Forest Service et al. 1993), Gregory and Bisson (1997), Hicks et al. (1991), Murphy (1995), National Research Council (1996), Nehlsen et al. (1991), Spence et al. (1996), Thomas et al. (1993), The Wilderness Society (1993), and others.

The relationship between habitat and population is embodied in the concept of carrying capacity. The concept of carrying capacity recognizes that a specific area of land or water can support a finite population of a particular species because food and other resources in that area are finite (Odum 1971). By extension, increasing the carrying capacity of an area (increasing the quality or quantity of resources available to a population within that area) increases the number of individuals the area can sustain over time. By the same reasoning, decreasing the carrying capacity of an area (decreasing the quality or quantity of resources available to a population) decreases the number of individuals the area can support over time. In either case, there is a corresponding, but non-linear relationship between changes in the quality and quantity of resources available to a species in an area and the number of individuals that the area can support.

The approach used in this assessment is intended to determine if the proposed action is likely to degrade the quantity and quality of natural resources necessary to support populations of coho salmon in the action area.

Table 5.6 - Baseline flows as measured at Iron Gate Dam (values in cfs) by water year type

	Above Average (19)		Below Average (11)		Dry (5)		Critical Dry (2)	
	Min	Ave	Min.	Ave.	Min.	Ave.	Min.	Ave.
October	1038	1565	1120	1368	972	1084	795	811
November	1384	2050	1447	1986	1374	1762	1126	1136
December	1639	2676	1384	2832	1643	2636	1445	1516
January	1819	3243	1772	3240	1730	2950	1953	2097
February	2105	4315	2403	3133	2001	2521	1630	1774
March 1-15	3176	4760	2750	3270	2213	2749	1745	1791
March 15-31	3129	5010	2802	3283	2246	2739	1726	1783
April 1-15	3215	4793	2605	2978	1877	2251	1590	1627
April 16-30	3357	4783	2491	2919	1717	2088	1572	1584
May 1-15	3409	4295	2156	2582	1794	1939	1362	1515
May 16-31	3115	4049	1901	2366	1713	1811	1175	1369
June 1-15	2420	3317	1552	1956	1369	1485	994	1045
June 16-30	1985	2834	1246	1692	1148	1313	847	897
July 1-15	1613	2180	1133	1398	838	1002	711	746
July 16-31	1222	1723	961	1183	651	827	645	668
August	1078	1373	753	1064	689	805	577	600
September	912	1331	861	1097	723	892	650	651

Table 5.7 – Flows as measured at Iron Gate Dam (values in cfs) resulting from the proposed action by water year type

	Above Average (19)		Below Average (11)		Dry (5)		Critical Dry (2)	
	Min	Ave	Min.	Ave.	Min.	Ave.	Min.	Ave.
October	1393	2635	1368	1600	1084	1084	811	811
November	1368	2500	1364	2238	1393	1393	1136	1136
December	1393	2655	1313	2986	1393	2188	1393	1393
January	1337	3145	1132	3036	946	2318	1393	1393
February	770	4061	1539	2389	1822	1970	1197	1197
March 1-15	2331	4885	2355	2769	2250	2368	1000	1000
March 15-30	2397	5074	2427	2777	2250	2376	1000	1000

April 1-15	2833	4326	1542	2063	1477	1725	1000	1000
April 16-30	3466	4399	2191	2400	1477	1535	1000	1000
May 1-15	2422	3251	1458	2007	1175	1175	796	898
May 16-31	2422	3194	1458	1892	1100	1100	796	898
June 1-15	1308	1723	660	1236	723	908	400	492
June 16-30	1000	1232	660	943	723	888	400	492
July 1-15	474	874	537	757	400	481	400	514
July 16-31	474	874	537	757	400	481	400	514
August	441	903	460	840	476	614	400	438
September	1000	1014	1000	1000	892	892	651	651

Table 5.8 - Habitat-discharge relationships for salmon in Klamath River (Iron Gate Dam-Shasta River). Source: INSE Phase II preliminary data

Discharge	Percent of optimal habitat	
	Chinook spawn	Coho fry
500	66	59
713	81	46
927	91	44
1140	97	44
1393	100	47
1647	100	48
1900	97	51
2191	90	58
2482	82	65
2773	74	71
3064	65	76
3365	57	81
4086	40	91
4817	28	97
5548	21	100
6365	16	89
7183	13	85
8000	12	81

Figure 1 is a graphic representation of the data in Table 5.8. The general assumption underlying habitat modeling is that aquatic species will react to changes in the hydraulic environment (Hardy and Addley 2001). These “habitat versus discharge” relationships were developed by first determining the hydraulic characteristics (e.g., depth and velocity) of the Klamath River mainstem channel between Iron Gate Dam and the Shasta River confluence as a function of discharge. This information was then integrated with habitat suitability criteria to produce a measure of available habitat (percent of optimal habitat) as a function of discharge (Hardy and Addley 2001). Habitat suitability criteria describe biological responses of target species and life stages to the hydraulic environment (i.e., how suitable a particular gradient of depth, velocity, substrate, cover, etc. is to a target species and life stage). For example, habitat suitability of depth is represented on a scale of 0.0 to 1.0. A suitability value of 0.0 represents a depth that is wholly not suitable, while a 1.0 value indicates a depth that is “ideally” suitable.

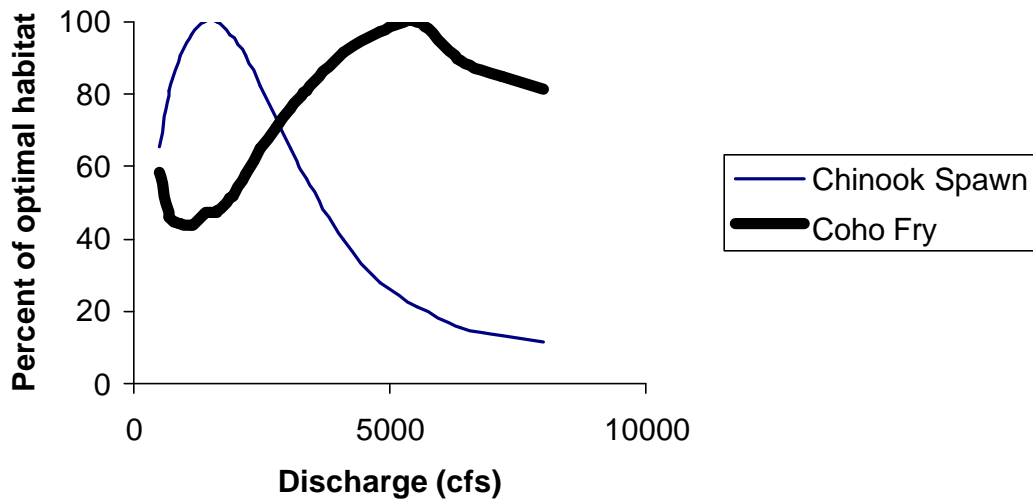


Figure 1. Habitat - discharge relationships for coho fry and chinook spawning in Klamath River, Iron Gate Dam - Shasta River. Source: Hardy

5.3.2 Analysis Approach

1. Flows as Measured at Iron Gate Dam

Figures 2 through 5 illustrate average flows at Iron Gate Dam with the proposed action (Table 5.7) and average baseline flows (Table 5.6) for coho salmon for each water year type. The method used to determine the effects of proposed water delivery and storage on threatened coho salmon in the mainstem Klamath River is to compare flows at Iron Gate Dam resulting from the proposed action with the baseline flow releases.

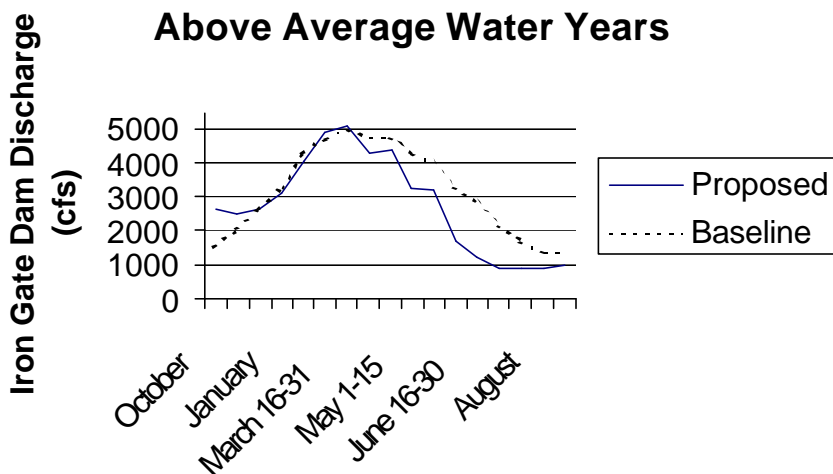


Figure 2. Average Iron Gate Dam flows during "above average" water year type under proposed action and baseline conditions.

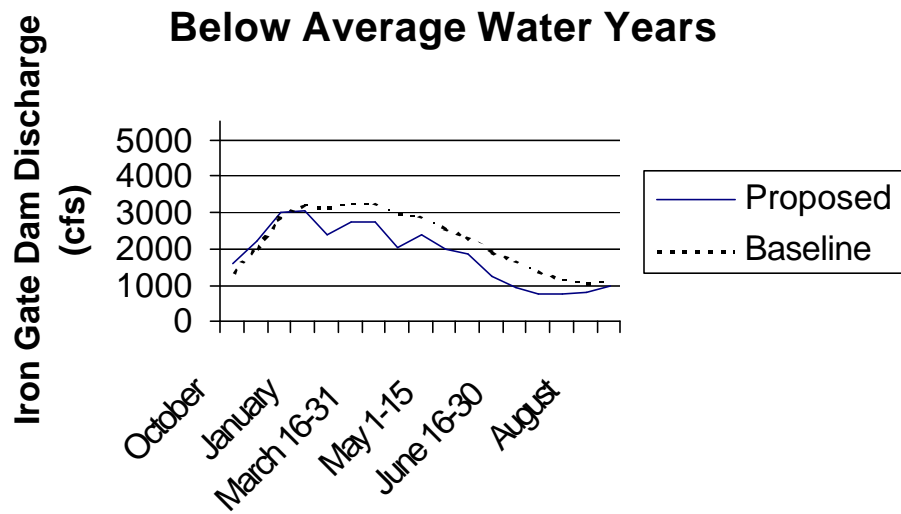


Figure 3. Average Iron Gate Dam flows during “below average” water year type under proposed action and baseline conditions.

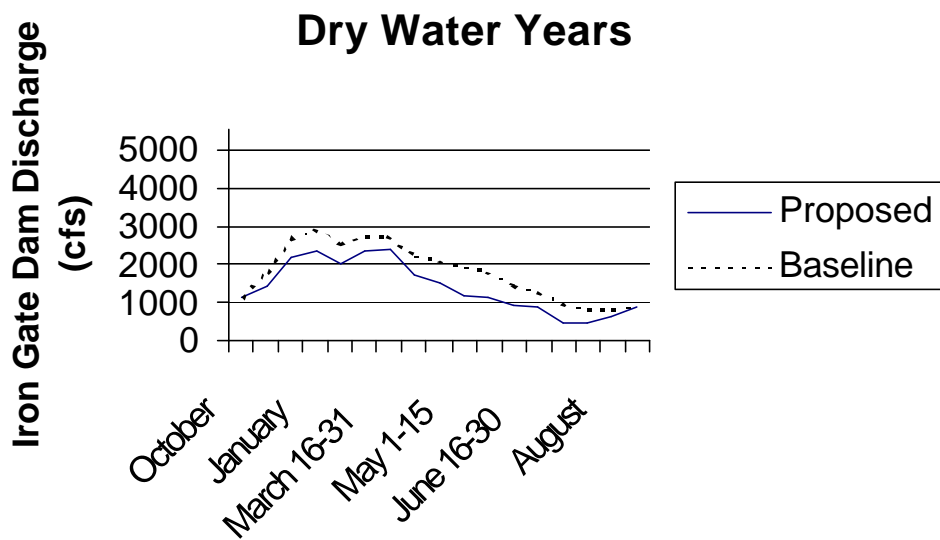


Figure 4. Average Iron Gate Dam flows during “dry” water year type under the proposed action and baseline conditions.

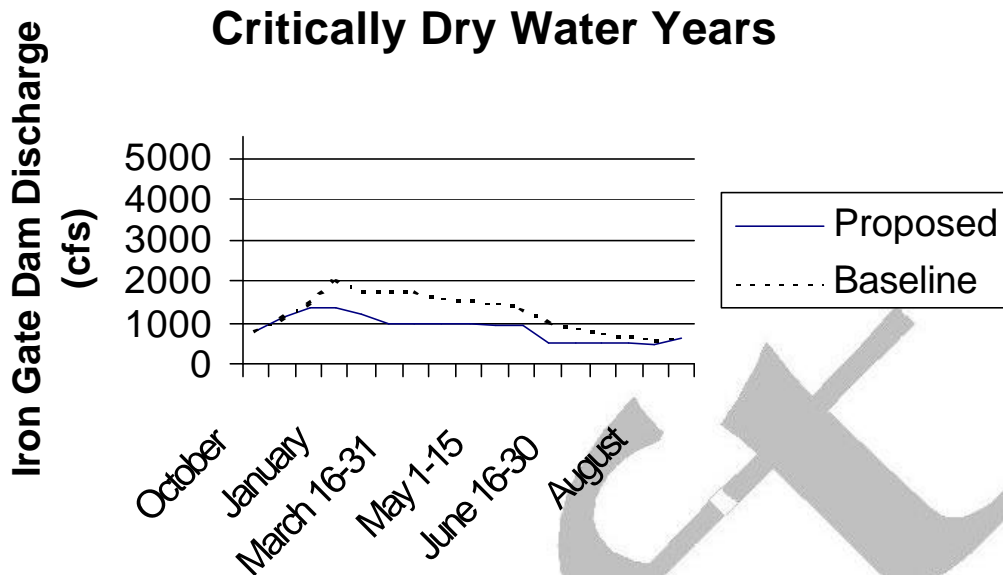


Figure 5. Average Iron Gate Dam flows during “critical dry” water year type under the proposed action and baseline conditions.

5.3.3 Habitat for Fry and Spawning Life Stages

The following approach was used to determine the effects of the proposed action on coho salmon habitat in the Klamath River. Philips Williams Associates (PWA) (2001) generated hydrologic time series data sets (flows at Iron Gate Dam location) with time steps from 1961 to 1997 without operation of the Klamath Project but with all physical facilities in place (no agriculture or refuge deliveries) and with net inflow into Upper Klamath Lake (i.e., impaired flows). This is the hydrological baseline condition. This data set and the hydrologic time series data set generated by KPOPSIM with the proposed action were integrated with the preliminary Iron Gate Dam to Shasta River habitat (percent of optimal habitat) versus discharge (cfs) relationships from the INSE (Hardy) Phase II study for coho fry and chinook spawning life stages (Table 5.6; Figure 1) to construct two sets of habitat time series (with and without the proposed action). Figure 6 illustrates this concept (Bovee 1982). There is no available information on the relationship between Klamath River flows and coho salmon spawning habitat. However, since fall chinook salmon utilize the mainstem Klamath River for spawning during the same period that coho salmon spawn (INSE 1999), chinook spawning was considered the best surrogate life stage for coho migration and spawning.

These life stages were considered highest priority for the following time periods:

- Coho fry - February - June 15
- Coho/chinook spawning - October - February

Habitat duration curves were then calculated from each set of habitat time series for each time step that the fry or spawning life stages are present. A habitat duration curve is a cumulative frequency plot that shows the probability of a certain amount of habitat being equaled or exceeded during a time period. For example, habitat values with exceedance probabilities greater than 90 percent represent extreme conditions of limited habitat. Habitat duration curves are constructed the same way as a flow duration curves, except that habitat frequency is used instead of flow frequency. The impact assessment was determined based on the percentage difference between the habitat duration values with the proposed action and the baseline. Figure 7 illustrates this concept (Bovee 1982). A similar analysis was done for chinook salmon spawning to assess effects on spawning and egg incubation habitat in the fall and winter.

A change in habitat with the proposed action compared to baseline of greater than or equal to 15 percent was used to assess the level of significant impacts of the proposed action on salmon habitat. The 15 percent level was based on experience and professional judgement of cumulative sources of uncertainty in the habitat modeling process, including measurement and modeling uncertainty associated with field measurements of physical habitat parameters

(depth, velocity, cover), model calibration, velocity simulations, habitat suitability criteria development, habitat modeling, and ability to replicate the results. Recognition of these sources of uncertainty and their relative magnitudes is important in the interpretation and use of habitat model results and the instream flow negotiation process (FWS 1992; Castleberry et al. 1996).

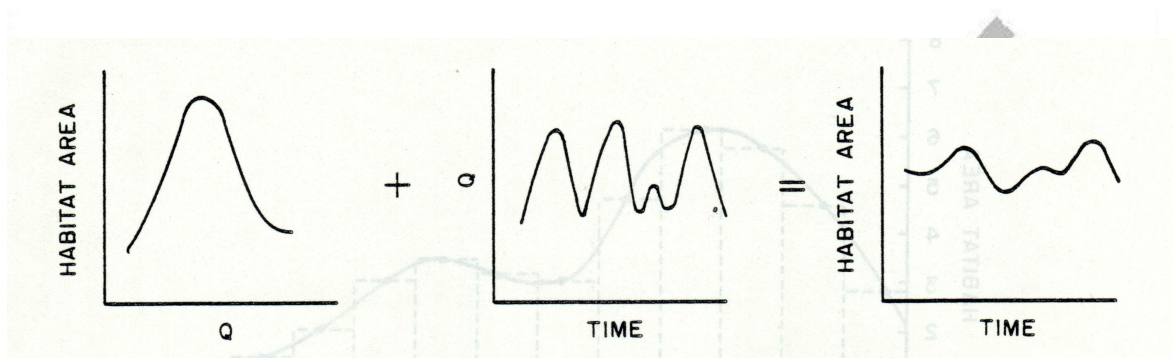


Figure 6. Illustration of habitat time series concept. Source: Bovee (1982).

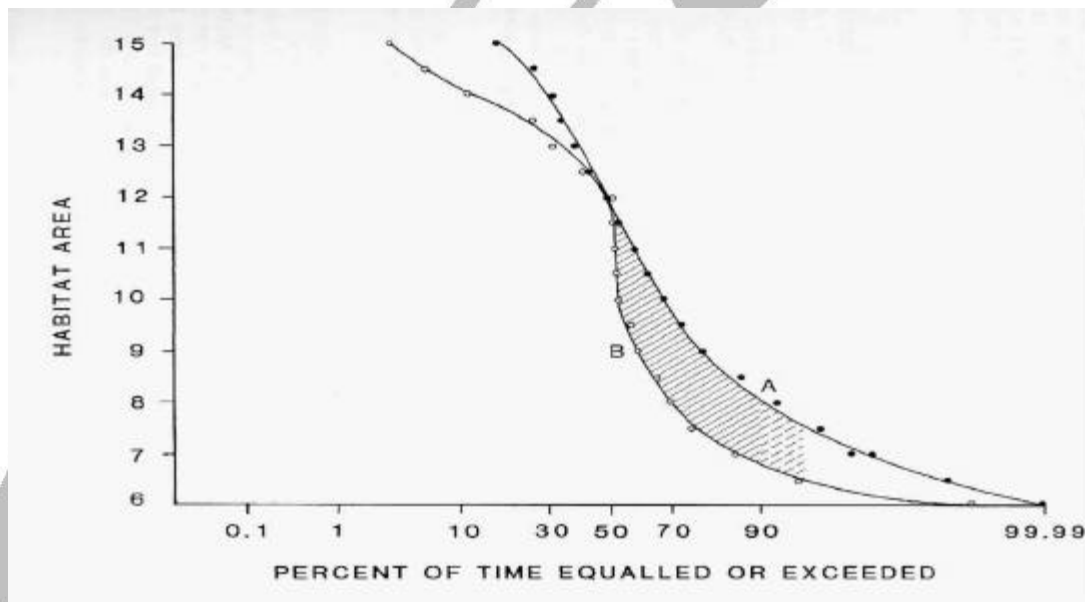


Figure 7. Concept comparison of habitat duration curves between two alternatives (A and B). Source: Bovee (1982).

5.3.4 Summer Water Quality Analysis

By mid-June, water quality deteriorates in the Klamath River. High water temperatures and low dissolved oxygen levels create an unfavorable environment for salmon. Thus, use of habitat time series to assess proposed action

effects on coho salmon during the summer is not appropriate. The approach used for the water quality analysis included modeling Klamath River water temperatures at various flows using RMA-11 model during the summer (Deas and Orlob 1999). This model was considered the most appropriate model to use because it uses short time steps (hourly) and is sensitive to small changes in flow. The one disadvantage of this model is that it only simulates water quality within the first 60 miles downstream from Iron Gate Dam to Seiad Valley. In addition to modeling temperatures, Reclamation compared flows at Iron Gate Dam between the proposed action and the baseline during the summer for various water year types.

5.3.5 Effects of Diverting Flows

The following proposed flow diversions, although occurring upstream of Iron Gate Dam, may result in diminished flow downstream of Iron Gate Dam and thus may adversely affect the salmon. The expanded analyses of these effects are included in later sections on water delivery (5.3.7—Effects of water delivery for Klamath Project purposes):

- * Diversion of flows at Agency Lake Ranch
- * Diversion of flows from the Klamath River (Lake Ewauna to Keno Dam)

5.3.6 Effects of Storing Water

Reclamation proposes putting water into storage (storing) water into Upper Klamath Lake year round with a significant portion of the water being put into storage during October through March. In some water years, storing is significant in April, May, and June. The following analysis considers the effects of storing water from October through March only.

Adult coho salmon migrate into the Klamath River between September and January. The requirements of adult coho salmon during this time include a migratory corridor with suitable water depth and velocities, resting pools, and adequate water quality conditions (NMFS 2001). Successful immigration also depends on adequate fish passage conditions in the mainstem Klamath River and access to tributaries.

Preliminary draft Phase II model results for chinook salmon spawning habitat indicate spawning habitat is optimal at approximately 1,300 cfs in the Iron Gate Dam to Shasta River reach (Table 5.8; NMFS 2001). Although it is reasonable to expect coho salmon to migrate successfully given this discharge and downstream flow accretions, this flow may not occur even under baseline conditions in “dry” and “critical dry” water years (Tables 5.6 and 5.7).

Average Iron Gate Dam flows (October through January) under the proposed action would vary from 811 to 1,393 cfs in “critical dry” water years to 2,500-3,145 cfs in “above average” water years (Table 5.7). This compares with baseline average flows of 811-2,097 cfs in “critical” dry water years to 1,565-3,243 cfs in “above average” water years (Table 5.6). These increments in flow changes related to the proposed action should not affect coho salmon migrations. Thus, lower flow resulting from the proposed action compared to baseline flows between October and January should not negatively affect coho salmon migrations.

Passage conditions from the mainstem Klamath River into some tributaries have been a concern under relatively low flow conditions (Vogel and Marine 1994), and tributary access would likely be adversely affected by the minimum flows that could occur in drier water years. The potential adverse effects to mainstem passage conditions and tributary access may result in spawning migration delays or straying due to natal stream inaccessibility. Because adult salmon do not feed during their freshwater spawning migration, individuals have a finite amount of energy reserves. Increased pre-spawning mortality and decreased spawning success may result from the proposed action.

Most coho salmon spawning typically occurs during December and January in Klamath River Basin (Weitkamp et al. 1995). Although coho salmon have been observed spawning in mainstem Klamath River (Reclamation 1998), it appears to be limited. Klamath River water temperatures during the spawning period would likely be within the acceptable range associated with coho salmon spawning in California (42-56 °F) (Briggs 1953).

Results of the spawning habitat analysis are summarized in Table 5.9. Examination of this habitat duration table shows that the proposed action generally increases spawning habitat compared to the baseline in January. Major increases in habitat would occur at the 50 and 70 percent exceedance levels in January with the proposed action (Table 5.9). Major spawning habitat losses would occur under extreme conditions in October (90 percent exceedance level, critical dry year) and in November (80 and 90 exceedance levels, dry and critical dry years) with the proposed action (Table 5.9). Spawning habitat levels with proposed action are relatively high between October and February, particularly at the lower exceedance levels where 100 percent of optimal habitat would occur between October and January at the 10 percent level and 100 percent at the 20 percent level in November and December (Table 5.9).

Table 5.9 - Chinook spawning habitat (% optimal habitat); Baseline compared to proposed action.

	OCTOBER			NOVEMBER			DECEMBER		
Exceedance	Baseline	Proposed	% change	Baseline	Proposed	% change	Baseline	Proposed	% change
90	92.3	53.5	-42.0	81.5	62.1	-23.8	45.2	38.6	-14.7
80	95.6	83.7	-12.4	88.5	72.6	-17.9	60.0	63.9	6.6
70	96.7	90.7	-6.3	91.2	78.1	-14.4	72.2	71.9	-0.3
60	97.4	94.8	-2.7	94.0	87.3	-7.2	77.6	81.8	5.3
50	98.4	95.1	-3.4	96.5	94.1	-2.5	84.2	93.9	11.6
40	98.9	99.7	0.7	98.1	97.3	-0.7	91.1	96.8	6.3
30	99.6	99.7	0.1	98.6	99.5	0.9	94.5	99.2	5.1
20	99.9	99.7	-0.2	99.8	100.0	0.2	96.9	100.0	3.2
10	99.9	100.0	0.1	100.0	100.0	0.0	99.9	100.0	0.1
	JANUARY			FEBRUARY					
Exceedance	Baseline	Proposed	% change	Baseline	Proposed	% change			
90	32.2	29.1	-9.4	20.6	18.7	-9.5			
80	45.1	42.6	-5.4	30.0	41.3	37.7			
70	58.8	70.0	19.1	43.3	57.2	32.1			
60	68.4	78.0	14.0	57.8	68.3	18.1			
50	74.0	90.3	22.0	65.7	82.8	26.0			
40	81.8	93.0	13.7	69.6	88.1	26.5			
30	89.0	96.3	8.2	75.9	95.1	25.3			
20	90.8	99.4	9.5	82.9	97.5	17.6			
10	97.4	100.0	2.7	93.2	98.0	5.2			

There is the potential effect during the spawning/egg incubation period of dewatering of incubating eggs if flows decline. Average proposed action flows generally decline between January and March in all water years except “above average” water years (Table 5.7).

Fry habitat in February and March is affected by the proposed action as shown in Table 5.10. Major decreases in fry habitat would occur with the proposed action compared to the baseline in February at exceedance levels > 50 percent (average to limited habitat conditions). Decreases may also occur in March. This would result in decreased carrying capacities for fry in the mainstem Klamath River and displacement of fry into less suitable habitat. As a result, survival of salmon fry is expected to decrease with the proposed action compared to baseline conditions.

Examination of Figures 2 to 5 shows that Iron Gate Dam flows with the proposed action would be similar to baseline conditions during the time when water is put into storage for Project purposes in “above average” and “below average” water year types. Flows with the proposed action would be less than baseline flows in “dry” and “critical dry” water years. This is likely to result in an adverse effect on coho salmon fry during this time period in “dry” and “critical dry” water years with the proposed action compared to the baseline.

Table 5.10 - Coho fry habitat (percent of optimal habitat) in Klamath River; Baseline compared to proposed action

Exceedance (%)	FEBRUARY			MARCH 1-15			MARCH 16-31		
	Baseline	Proposed	% change	Baseline	Proposed	% change	Baseline	Proposed	% change
90	55.9	45.3	-18.8	63.7	59.4	-6.8	63.9	59.4	-7.1
80	66.4	49.4	-25.7	73.2	63.2	-13.7	74.1	64.7	-12.6
70	72.0	50.2	-30.3	76.4	67.3	-11.9	77.3	67.8	-12.4
60	73.4	60.0	-18.3	79.8	71.8	-10.1	79.1	71.2	-9.9
50	77.0	65.7	-14.7	82.8	73.6	-11.2	82.9	74.0	-10.6
40	83.6	77.1	-7.7	87.6	79.2	-9.5	88.6	81.7	-7.9
30	88.9	79.9	-10.2	91.6	87.1	-4.8	92.0	87.5	-4.9
20	93.1	85.3	-8.4	94.7	92.2	-2.6	97.3	92.7	-4.8
10	96.9	93.9	-3.1	97.5	98.0	0.5	99.0	97.9	-1.1
Exceedance (%)	APRIL 1-15			APRIL 16-30			MAY 1-15		
	Baseline	Proposed	% change	Baseline	Proposed	% change	Baseline	Proposed	% change
90	59.0	47.6	-19.4	55.6	47.5	-14.6	51.8	44.2	-14.5
80	68.0	49.8	-26.7	65.1	58.6	-9.9	57.5	47.8	-16.9
70	72.5	50.9	-29.8	69.2	62.4	-9.9	62.3	57.0	-8.5
60	78.4	64.1	-18.3	79.9	63.4	-20.7	73.0	57.0	-21.8
50	82.1	74.1	-9.8	84.0	82.8	-1.5	82.2	66.8	-18.7
40	88.3	83.1	-6.0	88.2	83.1	-5.9	85.8	79.3	-7.6
30	94.3	87.2	-7.6	94.4	86.8	-8.0	91.6	79.3	-13.5
20	97.5	92.4	-5.2	97.9	92.8	-5.2	95.4	79.3	-16.9
10	98.9	98.2	-0.7	99.4	98.2	-1.2	97.3	80.9	-16.9
Exceedance (%)	MAY 16-31			JUNE 1-15					
	Baseline	Proposed	% change	Baseline	Proposed	% change			
90	49.5	43.9	-11.2	46.9	44.0	-6.2			
80	52.7	47.8	-9.4	48.8	44.4	-9.2			
70	61.8	52.9	-14.3	52.5	45.6	-13.2			
60	67.1	52.9	-21.2	55.4	46.1	-16.9			
50	77.6	66.8	-13.8	64.9	47.3	-27.2			
40	81.8	77.7	-5.1	70.7	48.6	-31.2			
30	89.7	77.7	-13.4	79.7	49.2	-38.3			
20	92.8	77.7	-16.3	83.8	49.2	-41.3			
10	96.8	80.7	-16.6	90.2	49.4	-45.2			

5.3.7 Effects of Water Delivery for Klamath Project Purposes

Water delivery for Project purposes includes both 1) delivery of water from Upper Klamath Lake storage; and 2) diversion of water from impaired inflows. The delivery of water from Upper Klamath Lake storage does not adversely affect baseline conditions on the Klamath River below Iron Gate Dam. Thus, any adverse effects in the following analysis are attributable to diversion of water from impaired inflows only.

The most critical period for young-of-the-year (YOY) salmonids occurs from March to early June (USFWS 1998). Young-of-the-year begin to emerge from spawning redds and seek out stream margins providing vegetated cover which, in turn, provides low velocity envelopes, protective cover from predators, and sources of food.

During this period, Reclamation is delivering stored water and diverting inflow. Table 5.10 shows that the proposed action generally adversely affects coho salmon fry habitat compared to the baseline. Decreases in habitat compared

to the baseline would occur in April, May, and early June with the proposed action. No major increases in habitat would occur during this period. This is likely to adversely affect coho salmon by decreasing carrying capacities for fry in the mainstem Klamath River and displacement of fry into less suitable habitat. As a result, survival of salmon fry is expected to decrease. Major habitat losses would occur in early April at the 60–90 percent exceedance levels; in late April at the 60 percent level; in early May at the 10, 20, 50, 60, and 80 percent levels; and in late May at the 10, 20, and 60 percent levels. The worst losses would occur in early June at the 10–60 percent levels (Table 5.10).

Primarily in dry and critical dry years we are stopping a portion of the impaired inflows. One concern with project operations is the effect of potential stranding of YOY coho salmon during decreases in Iron Gate Dam flows (NMFS 2001). For example, flows at Iron Gate Dam dropped from 3,300 cfs to 1,800 cfs the week of April 19, 1998, resulting in the stranding of coho fry (USFWS 1998). The extent of mortality was unknown; however, USFWS biologists rescued 7 coho salmon fry and 738 chinook salmon fry in 3 isolated edge water pools. The proposed action average flows in the April 1–15 time period decrease and then increase in late April for “above average” and “below average” water year types (Table 5.7). Reclamation will work closely with PacifiCorp and NMFS regarding flow changes at Iron Gate Dam that may occur during this period in any given year.

Although the relationship between flow and smolt survival has not been studied in the Klamath River Basin (NMFS 2001), Cada et al. (1994) concluded that relevant studies in other geographic areas “generally supported the premise that increased flow led to increased smolt survival.” Thus, smolt survival in the Klamath River is expected to be higher with higher flows, and lower with lower flows.

“Habitat bottleneck” refers solely to habitat limitations that affect populations of individual species (Wiens 1977). The basic premise is that populations of aquatic organisms are related to the availability of habitat through time. Adult populations are frequently determined by recruitment, which is highly correlated to the amount of habitat (microhabitat and macrohabitat) for early life stages of the species. There is generally a positive correlation between summer river flows and rearing habitat for juvenile salmonids (Bjorn and Reiser 1991; Binns and Eiserman 1979; Havey and Davis 1970; Matthews and Olson 1980 as cited in Satterthwaite 1987).

Relationship of Klamath River Flows to Fall Chinook Escapement, and Juvenile Abundance

Given the lack of coho-specific information on relationships between abundance and habitat, general trends in fall-run chinook salmon populations and their response to changes in mainstem macrohabitat and microhabitat conditions may provide a good approximation of the expected coho salmon responses to these changing conditions in the mainstem Klamath River. Both species, when considering the YOY and juvenile life stages, depend on edge habitat for velocity shelters, protection from predators, and food sources. Klamath fall-run chinook adult returns typically consist of five age classes but are dominated by 3 and 4-year old fish.

There has been speculation that the relatively high escapement observed in 1995 and 1996 reflected freshwater conditions in 1992 and 1994 (Table 5.11). The relative strength of adult returns in both years may be attributed to very good ocean conditions and excellent microhabitat rearing conditions in the Klamath River in 1993. Despite drought conditions in 1992 and 1994, it appears high flow conditions in the mainstem and tributaries in 1993 compensated somewhat for poor microhabitat and macrohabitat conditions in the watershed below Iron Gate Dam in 1992 and 1994.

The relationship between Klamath River fall-run chinook escapement, juvenile chinook abundance, and Klamath River flows was evaluated by Craig (1998). Data from 1988 to 1998 (Table 5.11) showed a weak positive correlation ($r = 0.194$) between average daily river flow and natural juvenile chinook abundance. Data from 1989/1990 (escapement year/juvenile index year) were not included because unseasonable late spring rains in 1990 severely reduced the ability to conduct monitoring during a period of significant hatchery and natural stock emigrations (Craig 1998). There was also a weak positive correlation ($r = 0.261$) between spawning escapement and juvenile chinook abundance. These correlations improved when the 1993/1994 (escapement year/juvenile index year) data point was omitted. Craig (1998) speculated that the high juvenile abundance in 1994 was due to several related factors: 1) relatively low escapement in the fall of 1993 (reduced density-dependant factors); 2) low and consistent (absent significant flow peaks) late fall-spring tributary flows and; 3) the inherent productivity of Klamath

Basin waters. Craig (1998) stated that "... it is a difficult, if not impossible, task to clearly ascertain which factor or combination of factors most affected a particular adult run-size or influenced the magnitude and/or health condition of the Basin's annual juvenile salmonid production."

Total 1999 fall-run chinook salmon spawning escapement into the Klamath River system was estimated at 52,538 fish (CDFG 2000). This included 19,719 natural adults, 14,915 hatchery returns, and 17,904 in-river fishing harvest (CDFG 2000). Natural juvenile chinook abundance indices for 1999 and 2000 were 367,036 and 287,000, respectively, at Big Bar (FWS 2001). Mean flows (May-July) in 1999 and 2000 were 9,978 and 5,173 cfs, respectively (FWS 2001). For comparison, indices for natural juvenile coho abundance in 1999 and 2000 at Big Bar totaled 6,033 and 4,256, respectively (FWS 2001).

Given the complexity involved with attempting to quantify these relationships, effects of Klamath River flows resulting from the proposed action on coho salmon escapement and juvenile abundance would be difficult to assess.

Table 5-11. Natural adult fall chinook spawning escapement (1988-1997, 1989 omitted), natural juvenile chinook abundance index (1989-1998), 1990 omitted) and average daily Klamath River flow during May-July (1989-1998, 1990 omitted), with corresponding ranks (1 = highest, 9 = lowest) (Craig 1998).

Year	Spawning Escapement ¹	Rank	Year	Juvenile Index ²	Rank	River Flow ³	Rank
1988	29783	3	1989	135200	7	5628	5
1990	7102	7	1991	55169	9	3461	7
1991	5905	8	1992	165227	6	1975	9
1992	4135	9	1993	220439	5	11519	2
1993	9453	6	1994	1334078	1	2476	8
1994	20960	5	1995	302581	4	9856	3
1995	79851	1	1996	826188	3	8684	4
1996	31755	2	1997	128465	8	5182	6
1997	28415	4	1998	1038520	2	13900	1
Avg.	24151			467319		6965	

¹ Spawning escapement = natural adult fall chinook spawners in the Scott, Shasta, and Salmon Rivers, Bogus Creek and mainstem Klamath River.

² Juvenile abundance index = Sum of daily catch of natural juvenile chinook x (mean daily river flow (cfs)/volume of river flow sampled (cfs)).

³ Flow = average mean daily Klamath River flow at Orleans USGS gage during May - July.

Water temperatures and water quality in mainstem Klamath River contribute to unfavorable environmental conditions for juvenile salmon during the summer (late June-September). Thus, an analysis of physical habitat during this period is not appropriate.

River flow can directly impact water temperatures in the Klamath River (Deas 2000). Preliminary flow and temperature simulations using the RMA-11 model in the sixty-mile reach from Iron Gate Dam to Seiad Valley suggest that during summer periods lower flows generally lead to higher downstream temperatures. Simulated temperature response for a typical mid-summer day at various Iron Gate Dam flows illustrates the flow-temperature interdependence. At 500 cfs, simulated daily mean water temperature increases 2.5 ° C (4.9 ° F) over the sixty mile

reach from Iron Gate Dam to Seiad Valley, while at 3,000 cfs the simulated increase is roughly 0.9° C (1.6 ° F) (Table 8) (Deas 2000; Deas and Orlob 1999). Water temperatures are elevated at low flow rates because of an increase in transit time, less thermal mass allowing greater heating during the day, and shallower river conditions. At 500 cfs, a mean simulated temperature of approximately 25° C was recorded at Seiad Valley, compared to about 23° C at 3,000 cfs in mid-August (Deas 2000; Deas and Orlob 1999). Thus, high water temperatures can occur at high and low flows, depending on climatic conditions. The extent to which Project operation affects water temperature is complex and remains unclear (Balance Hydrologics 1996).

Diurnal water temperatures, including maximum and minimum values, are also affected by flow regime. For low flows, daily maximum temperatures are higher and daily minimum water temperatures are lower, while at higher flows water temperature daily maximums are lower and minimum temperatures higher (INSE 1999).

Table 5.12 - Simulated effects of fiver flow on water temperatures in the Iron Gate Dam to Seiad Valley reach of the Klamath River for a typical mid-summer day

Simulated Iron Gate Dam flow (cfs)	Simulated net temperature increase in the Iron gate Dam to Seiad valley reach in °C and (° F)
500	2.5 ° C (4.5 ° F)
1000	2.1 ° C (3.8 ° F)
2000	1.3 ° C (2.3 ° F)
3000	0.9 ° C (1.6 ° F)

Available information suggests that flows resulting from the proposed action may not influence temperatures dramatically in the Klamath River at Seiad Valley (Table 5.12).

Young-of-the-year survival, growth, and recruitment depend on the availability of total habitat, including suitable macrohabitat (water quality and temperature) and suitable microhabitat (depth, velocity, and cover) conditions under different river flows. The availability of suitable microhabitat may not be a primary factor in the survival of YOY salmonids when acute water temperatures prevail. Chronic (>15° C) and acute (>20° C) water temperatures for salmonids in the Klamath River are based on an evaluation of existing published information on observed relationships between water temperature and chinook salmon tolerances (Bartholow 1995). These “thresholds” may create a population bottleneck by impacting YOY and juvenile coho in late July and August. The fact that juvenile salmonids persist in the Klamath River mainstem despite temperatures that generally exceed these chronic and acute temperature thresholds (Yurok Tribal Fisheries Program 1999, 2000) illustrates the complexity of this issue. Additional site-specific studies are needed to better understand the relationships between river flow, water temperature, microhabitat, and salmonid health in the Klamath River.

Examination of Figures 2-5 shows that Iron Gate Dam flows during periods of water delivery (April-September) are less than baseline for all time steps of all water year types except in September of “dry” and “critical dry” water years. The proposed action could put rearing salmonids at risk July and August as a result of a combination of high water temperature (>15° C), low dissolved oxygen, and low flows. Thus, Iron Gate Dam flows during water deliveries are likely to adversely affect SONCC coho salmon and critical habitat for SONCC coho salmon during all water year types except in September of “dry” and “critical dry” water years.

5.3.8 Effects of Other Proposed Actions

There should not be any additional effects on coho salmon from the other proposed actions.

5.3.9 Summary of Effects

Implementation of the proposed action (when compared to the environmental baseline) is likely to have the

following effects on threatened SONCC coho salmon and critical habitat for SONCC coho salmon:

1. Diversion of water as described in section 5.3.5, although occurring upstream of Iron Gate Dam, may result in diminished flow downstream of Iron Gate Dam and thus may adversely affect the salmon.
2. Flows resulting from the proposed action between October and January should not adversely affect coho salmon migrations.
3. Increased pre-spawning mortality and decreased spawning success may result with the proposed action.
4. Klamath River water temperatures during the spawning period would likely be within the acceptable range associated with coho salmon spawning in California (42-56 °F).
5. The proposed action generally enhances spawning habitat in the Klamath River in January. Major spawning habitat losses would occur under extreme conditions in October and November.
6. Flows below Iron Gate Dam with the proposed action during the time when water is put into storage would be less than baseline flows in “dry” and “critical dry” water years. This is likely to result in an adverse effect on coho salmon fry during this time period in “dry” and “critical dry” water years by decreasing carrying capacities for fry in the mainstem Klamath River and displacement of fry to less suitable habitat.
7. Average proposed action flows generally decline between January and March of most water years. This may affect the limited amount of coho eggs that incubate in the mainstem Klamath River.
8. Major decreases in fry habitat would occur in February, April, May, and early June with the proposed action. This is likely to result in an adverse effect on coho salmon fry during this time period by decreasing carrying capacity for fry in the mainstem Klamath River and displacement of fry into less suitable habitat.
9. Available information suggests that water deliveries may not influence temperatures dramatically in the Klamath River at Seiad Valley.
10. Flows below Iron Gate Dam during periods when water is diverted from impaired flows (April-September) are less for all time steps of all water year types except in September of dry and “critical dry” water years. This could place rearing coho salmon at risk in July and August as a result of a combination of high water temperature (>15 C), low dissolved oxygen, and low flows.

5.4 EFFECTS ON BALD EAGLES

5.4.1 Background

The FWS's April 5, 2001 final BO concluded that Reclamation's proposed action (i.e., continued operation of the Project to deliver a water supply for irrigated agriculture and refuges) for 2001 is not likely to jeopardize the continued existence of the bald eagle. Reclamation agrees with this conclusion.

The 2001 Annual Operations Plan for the Project, which was developed in conformance with the FWS and NMFS biological opinions, resulted in severely reduced agricultural and refuge water supplies that benefit bald eagles. Reclamation was able to obtain water in 2001 through cooperative means from water users in the Basin to provide the protections sought by the FWS, and would continue to take similar cooperative actions in the future. The BO also stated that Reclamation's action is likely to result in a significant reduction or elimination of the prey base for the bald eagle due to reduced or curtailed water deliveries to areas that contain important eagle feeding habitat. The BO included non-discretionary reasonable and prudent measures (RPM) to minimize incidental take of bald eagles.

Reclamation believes any effects on the bald eagle that may have occurred during 2001 resulted primarily from the FWS's and NMFS' RPA requirements and not entirely from Reclamation's proposed actions. Certain conservation measures may be appropriate relative to long-term operations of the Project, however, and Reclamation would like to discuss these with the Service during further consultation.

draft

CHAPTER 6.0 - CUMULATIVE EFFECTS

6.1 CUMULATIVE EFFECTS

Cumulative effects are those effects of future non-Federal (State, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonably certain to occur within the action area of the Federal activity subject to consultation.

6.2 LOST RIVER AND SHORTNOSE SUCKERS

6.2.1 Clear Lake Watershed

Most of the land in the Clear Lake watershed is Federally owned and actions affecting listed species will undergo section 7 consultation and thus are not considered in this section. Remaining land is in private ownership and is mostly open juniper-bunchgrass rangeland with some small forest areas of ponderosa pine. Few people live in the area. Reclamation anticipates that most of this land will be used as it has in the past as range (grazing) and forest (logging).

Private land grazing in the Clear Lake watershed is not considered to be a significant threat because limited areas of private rangeland are located in the watershed. Grazing in the Clear Lake watershed has previously destabilized streambank vegetation resulting in erosion, siltation, reduced quality of gravel and cobble spawning areas, increased water temperatures, wider and shallower stream channels, and lowered water tables. Conditions of rangelands are anticipated to continue to improve with proactive management.

Forestry practices on private lands may also contribute to water quality declines in the upper Clear Lake watershed, but because commercial forest comprise such a small area and will be infrequently harvested that Reclamation does not consider future forestry practices a significant threat in this watershed.

Introduced fishes such as brown bullhead, fathead minnow, Sacramento perch, pumpkinseed, green sunfish, bluegill, and largemouth bass are likely to continue to persist in the Clear Lake watershed. However, because relatively stable sucker populations co-exist with abundant non-native fish populations in Clear Lake and its tributaries, Reclamation does not consider non-native fish to be a major threat.

Transportation of hazardous materials along roadways in the Clear Lake watershed and use of herbicides, and pesticides appear to be a small risk owing to their infrequent presence in the watershed.

6.2.2 Gerber Reservoir Watershed

There are several small private water developments in the Gerber Reservoir watershed. These developments are used primarily for livestock operations. Each of these operations use a combination of dams, reservoirs, and ditches to distribute water or use dikes, ditches and canals to irrigate their lands for pasture and hay, and grain cultivation.

The effects of these impoundments on the shortnose sucker populations in the Gerber Reservoir watershed are unknown. During wet periods suckers are suspected to occupy some of these impoundments. Water storage may increase instream flows during the summer. The impoundments also may trap sediments keeping them out of downstream pools and riffles where suckers reside or spawn. The net effect of these developments may be neutral or even beneficial to suckers.

Land use in the Gerber Reservoir watershed is similar to that of Clear Lake, perhaps with more commercial timber on private lands. Future forestry and grazing practices that follow established best management practices are not considered to be a significant threat to shortnose suckers in the Gerber Reservoir watershed.

Introduced fish including fathead minnows, yellow perch, crappie, brown bullhead, largemouth bass, pumpkinseed, and green sunfish are likely to persist in the Gerber Reservoir watershed. However, because relatively stable shortnose sucker populations co-exist with abundant non-native fish populations in Gerber Reservoir, Reclamation does not consider non-native fish to be a major threat.

Transportation of hazardous materials along roadways in the Gerber Reservoir watershed and use of herbicides and pesticides appear to be a small risk owing to their infrequent presence in the watershed.

6.2.3 Lost River

Most of the low-lying land in the valleys adjacent to the Lost River (Langell Valley, Yonna Valley, Poe Valley) are privately owned and used for agriculture. These lands contribute nutrients, sediment, fertilizers, herbicides and pesticides to the Lost River and the Tule Lake sumps that will affect listed suckers. Many of these lands receive water from the Klamath Project. Several dairy operations are found in the Langell and Poe Valleys that contribute nutrients to the Lost River. Additionally, nutrients from residences along the River and sewage treatment facilities in Bonanza, Merrill, and Tule Lake on occasion make their way into the River. Other potential sources of nutrients include a feed processing plant in Merrill and food processing facilities in Hatfield.

There are approximately 60 unscreened pump or gravity diversions in the Lost River and Tule Lake Sumps. Most of these diversions will likely continue to entrain endangered suckers.

Fish passage is blocked at three private diversion dams on the Lost River including Lost River Ranch, Harpold Dam and Bonanza Dam. These seasonally operated dams prevent upstream migration of suckers during the spring and summer.

6.2.4 Upper Klamath Lake Watershed

Private landowners along streams tributary to UKL annually exercise their State of Oregon rights to withdraw water for irrigation and livestock watering. The total amount of water that is annually withdrawn before it reaches UKL has not been determined but it is thought to be substantial. It is estimated that about 110,000 acres benefit from diversions above the Project boundaries. Nutrient enriched return flows from these upstream agricultural lands coupled with the reduced inflows to the lake, because of irrigation depletion, likely contribute to the eutrophication in UKL.

Despite high background total phosphorus (TP) levels in UKL tributaries and springs (Kann and Walker 1999, Rykbost 1999), data exists from several studies to indicate that TP loading and concentrations are elevated substantially above these background levels. Considerable contributions of phosphorus stemming from wetland loss, flood plain grazing, flood irrigation, and channel degradation, likely accounts for a high percentage of the nutrient loading. The estimate of anthropogenic contribution of TP loading to Upper Klamath Lake is 40% (Kann and Walker 2000). These values are very similar to the 40% anthropogenic TP contribution estimated by Walker (1995) for Agency Lake.

Approximately 15,000 acres of drained wetlands around UKL are being restored. The immediate benefit from these lands is that management will emphasize water quality improvement in UKL. Management actions on these lands that once contributed nutrients to UKL have been stopped or significantly reduced. Restoration on the Running Y Ranch Resort includes up to 500 acres of marsh habitat. Other activities likely to occur include large-scale riparian restoration along the major tributaries of UKL through fencing and improved grazing practices, and wetland restoration. The Nature Conservancy recently purchased Tulana and Goose Bay Farms, 8,000 acres at the mouth of the Williamson River. Acquisition and restoration of this property has great potential for restoring sucker habitat, and improving water quality in UKL. TNC has also purchased an additional 7,000 acres at Sycan Marsh expanding its preserve to over 25,000 acres. This acquisition and restoration of the Marsh should improve water quality and hydrologic function in the Sycan and Sprague Rivers, tributaries to UKL.

There are approximately a dozen large, non-federal, unscreened diversions in UKL that supply water to about 15,000 acres of agricultural lands and restored wetlands around UKL. These diversions will likely continue to entrain substantial numbers of larvae and juvenile suckers.

6.2.5 Agency Lake and Wood River Watershed

Numerous ranches in the Fort Klamath area divert significant quantities of water out of the various streams and springs in the watershed upstream and adjacent to Agency Lake north of UKL. The natural streams in this area include: Sevenmile Creek, Fourmile Creek, Annie Creek, Crooked Creek, and the Wood River. Additionally, water from various natural springs is diverted to various maintained ditches that supply irrigators in the area. Major ditches conveying water from the natural creeks and springs to the irrigators include: Bluespring, Sevenmile, and Melhase Ditches. Return flows from these ditches are collected into several canals that connect with and are adjacent to Agency Lake. These canals contain water year round and include: West, Sevenmile, Central, and North Canals among others. The Meadows Drainage District and many individual landowners divert water through the aforementioned ditches.

Larval and juvenile Lost River and shortnose suckers are known to occur in the Wood River, Seven Mile Creek and Crooked Creek. It is suspected that some of these suckers may be spawning in the Wood River and Crooked Creek. Depending on how far these spawning fish migrate upstream, the adult spawners, embryos, and emerging larvae of these suckers may be impacted by water diversions from these tributaries. If spawning suckers are in downstream reaches of the Wood River and Crooked Creek below irrigation diversions when water deliveries to the ditch systems are diverted out of the channel, then the spawning behavior of these fish may be disrupted resulting in no sucker spawning in that year. If suckers succeed in spawning within the reaches upstream of the diversion ditches, the larval life-stage would potentially be subject to diversions into canals and fields, reduced flows and resulting elevated water temperatures during incubation and larval emigration.

Depending on land practices, use of fertilizers, herbicides, and other chemicals, the number of reuses, and erosion in this agricultural area, the water quality (including dissolved oxygen, turbidity, and temperature) of these return flows could range from fair to poor. The return water, upon collection in the downstream canals, could then potentially impact the water quality of Upper Klamath Lake Marsh, Wood River Marsh and near-shore habitats of larval, juvenile, and/or adult suckers or other fishes present. Nutrient rich irrigation return water reaching Agency Lake could result in algae blooms and anoxic conditions within Agency Lake itself. These noxious blooms and resulting degraded water quality could potentially result in fish kills in Agency Lake during the late summer months.

6.2.6 Williamson River Watershed

In the Upper Williamson River watershed, past grazing and forestry practices have adversely affected stream morphology, with the result that the river has become entrenched. Agricultural practices in the drainage could have the same effects as those listed above for the Agency Lake drainage. Private landowners have taken measures to improve watershed conditions in recent years through proactive land management.

Unscreened, non-federal, irrigation diversions on the lower Williamson River in the area of concentrated larval migration and rearing may be reducing sucker recruitment to UKL. Irrigation diversions also reduce stream flows. Residential development along the lower Williamson River could adversely affect riparian areas when native vegetation is removed and stream banks are modified. These developments may also contribute nutrients through septic tank leaching, and fertilizer runoff from lawns.

6.2.7 Sprague River Watershed

Chiloquin Dam, located just upstream of the Sprague River's confluence with the Williamson River, is estimated to have restricted access to more than 95% of the potential spawning habitat for the LRS and SNS and is considered one of the more significant reasons contributing to the decline of the suckers (USFWS 1993). Although fish passage facilities on the dam have been installed, the dam has restricted annual migrations for endangered suckers (USFWS 1993). Legislation is pending in Congress to study fish passage options in preparation for implementation of a solution.

Spawning and rearing habitat in the Sprague River has been degraded by channelization, sedimentation, increased water temperatures, high nutrient concentrations, and the resulting high algae and aquatic plant growth. These problems originate in the Sprague River Valley, upstream of the present-day spawning areas, where agricultural activities have degraded the riparian habitat. In addition to the resulting loss of spawning habitat and rearing habitat, the Sprague River is a major contributor of excess nutrients to the hypereutrophic UKL. Long-term successes of spawning habitat restoration efforts in this river system depend almost entirely on rehabilitation of the upstream reach of the Sprague River (USFWS 1992). Several landowners have initiated riparian and wetland restoration projects in the Sprague River Valley. These projects should improve watershed conditions and reduce nutrient loading to UKL.

6.2.8 Keno Reservoir

At least 55 unscreened private and irrigation district agricultural diversions exist on Keno Reservoir. Oregon Department of Fish and Wildlife has eight diversions for the Miller Island Wildlife Area, three of which are screened and plans are underway to screen others.

Water quality on Keno Reservoir can at times be degraded due to treated sewage from two municipal sewage treatment plants, storm water and non-point source runoff from the City of Klamath Falls. Lumber mills along the Klamath River near Klamath Falls also contribute to water quality problems in the river. The Klamath Straits Drain, which receives return flows and storm runoff from private agricultural lands, municipalities, dairies, and refuges and the Project, contributes nutrients, sediment, herbicides and pesticides to the Klamath River. Other inputs include the Lost River Diversion Canal, Link River, and sediment sources. The highly enriched sediments were caused in part by decades of intensive lumber mill operations and log rafting on Lake Ewauna during the first 60-70 years of the 20th century. The impoundment of the nutrient rich waters in the reservoirs are known to contribute to algae blooms within the reservoirs and cause downstream algal nuisance conditions in the river.

The wastewater treatment facilities are likely to reduce their pollution loads to Keno Reservoir over the next decade to comply with the Clean Water Act TMDL (Total Maximum Daily Load) process.

6.2.9 Other Cumulative Effects

The transportation of hazardous materials by truck and train along the eastern and southern margin of UKL and over tributaries could result in spills and negative impacts to the listed and unlisted species in the basin's waters. Algae and Daphnia harvesting in UKL may result in the take of larval and juvenile suckers. The use of chemicals such as pesticides, herbicides, and mosquito or midge control chemicals could result in negative impacts to listed species throughout the basin. The diversion of water directly from UKL by private (non-Project) water users may result in the taking of suckers and reduction of habitat.

6.3 COHO SALMON CUMULATIVE EFFECTS

6.3.1 General Cumulative Effects on Coho Salmon

For the purposes of this analysis, the action area encompasses the Project and aquatic habitat downstream from Iron Gate Dam in the Klamath River.

Cumulative effects of State and private activities on anadromous fish species in the Klamath Basin are significant. Since 1906, fish habitat conditions throughout the watershed including headwater streams, Upper Klamath Lake (UKL), the Klamath River from Link River Dam to Klamath California, IGD and tributaries below IGD have been altered by human activities. Marshlands surrounding Upper Klamath Lake have been converted to agricultural use diminishing the capacity of the lake to reduce nutrient levels.

Klamath Basin anadromous fisheries have declined precipitously since the early 1900's (INSE 1999). Normally, robust populations can withstand environmental perturbations and recover over time; however, this is not case for anadromous fishes in the Klamath River for the following reasons. Loss of fish habitat, problems with chronic and

acute water temperatures and excessive nutrients, commercial over harvest, and climatic changes have resulted in declining populations of steelhead, chinook and coho salmon. The combination of timber management practices, agricultural practices, placer mining, water diversions in the Scott and Shasta River watersheds and the construction of hydroelectric dams appear to have individually, and cumulatively caused significant reduction in spawning, rearing, and emigration habitat throughout the watershed. Loss of these habitats has resulted in declining populations.

During the last 40 years, a large body of information has been collected regarding the effects of water temperature on salmonid adult migration, spawning, egg incubation, alevin emergence, fry and juvenile rearing. Bartholow's (1995) literature review of salmonid temperature tolerances and study of Klamath River water temperatures support the premise that high summer temperatures ($\geq 15^{\circ}\text{C}$ from late June through early September) have a detrimental effect on coho and chinook salmon and steelhead trout.

High water temperatures found in the river are primarily a function of climate and massive landscape changes that have occurred throughout the Klamath River watershed. Water temperatures recorded at Klamath in the early 1900's (pre-project) indicate the Klamath River was, on average, several degrees cooler than present (M. Belchik, Yurok Tribe, per. comm. 1998). Additionally, flow blockage by dams and degradation of tributary habitat have eliminated most or all of the thermal refugia areas in the upper portion of the Klamath River below IGD thus forcing greater reliance on mainstem habitat (M. Belchik, Yurok Tribe, per. comm. 1998).

Fish kills occur in the lower Klamath River and Upper Klamath Lake due to poor water quality. For example, bacterial fish diseases such as *F. columnaris* thrive in high water temperatures typical of the summer months in the lower river. *Aeromonas hydrophyla*, another bacterial disease and anchorworm, a parasitic copepod, are also indicators of the stresses affecting the fisheries. High water temperatures and low dissolved oxygen combined with bacterial diseases and parasites were largely responsible for the 1997 and 2000 fish kills downstream from IGD. Dead salmon are typically collected annually during the second week in August in fish traps monitored by the Service at Big Bar (river mile 50). These deaths are attributed to heavy algal loads and high water temperatures (T. Shaw, Service, per. comm. 2000).

Water diversions from Klamath River basin tributaries have played a significant role in the decline of Klamath River salmonids. Historically, tributaries played a vital role in sustaining coho, steelhead, and chinook stocks in the Klamath Basin. Diversions on tributaries during the irrigation season (May to October) reduce stream flow. These low flows prevent fall chinook from migrating up the Scott River past Etna Creek (river mile 42.2) during average to dry years (D. Rogers, CDFG, per. comm., cited in Vogel 1997). Low flows also limit coho and steelhead juvenile rearing habitat and can strand juvenile fall chinook, coho, and steelhead when the irrigation season begins (CH2M Hill 1985 cited in Vogel 1997). These activities have also altered water temperature, water quality, and the duration, frequency, and magnitude of Klamath River flows.

Watershed conditions in the Klamath River Basin exhibit a legacy of over a hundred years of livestock grazing, some of which was very intensive. The Shasta and Scott Rivers have a long history of stream diversions. Diversion dams block salmon from migrating upstream. Riparian vegetation has been extensively reduced or removed along the Shasta and Scott rivers, as well as other tributaries, causing increased water temperatures and lack of instream cover for salmon and steelhead. Unscreened or ineffectively screened diversions have resulted in fish strandings. In one documented case on a tributary of the Scott River, the following stranded fish were counted: 1,488 young steelhead and 105 young coho salmon (Taft and Shapovalov 1935 cited in Vogel 1997). Agricultural practices in the Lost, Shasta, and Scott River watersheds may have released herbicides and pesticides into the Klamath River. However, no evidence exists indicating adverse affects of pesticides or herbicides on Klamath River resident or anadromous fish. Livestock wastes and fertilizer runoff contributes excess nutrients (nitrogen and phosphorus) to the stream. As a result, aquatic plant and algae growth is stimulated. After these plants die, the decomposition process by bacteria can demand more oxygen than the living plants produce, which lowers the oxygen levels in the stream (Vogel 1997). In combination with high temperatures and low streamflow, these decreased oxygen levels can be stressful or lethal to adult and juvenile salmon. Critically low levels of oxygen have been measured in the Shasta River in recent years (D. Maria, CDFG, per. comm. cited in Vogel 1997).

Upper Klamath Lake and the Klamath River are highly eutrophic systems from naturally and man-caused phosphorous and nitrogen compounds and pollution in the form of ammonia and nitrates. Waste water from Klamath sewage treatment plant, U.S. Timberlands, and South Suburban sewage; leachates from the Columbia

Plywood log storage facility; return water from the Project area; and irrigation returns in the Scott and Shasta watersheds all contribute to the high nutrient load and biological oxygen demand in the Klamath River above and below IGD. High nutrient levels promote plant and algal growth, which cause diel fluctuations in the river's dissolved oxygen level because of plant respiration. Water quality degradation resulting from these activities cannot be discounted as a major factor contributing to the decline of Klamath River steelhead, coho, and chinook.

Commercial ocean fisheries have also reduced salmonid stock abundance in the Klamath River system up to 70 percent (Rankel 1980 cited in Vogel 1997). Marine harvest in the Oregon Coast and SONCC ESUs occurs primarily in nearshore waters off Oregon and California (Weitkamp et al. 1995). Commercial landings of coho salmon in Washington, Oregon, and California show relatively constant landings between 1882 and 1982, ranging between 1.0 and 2.5 million fish, with a low of 390,000 fish in 1920 and a high of 4.1 million fish in 1971 (Shepard et al. as cited in Weitkamp et al. 1995). Coho salmon landings off the California and Oregon coast ranged from 0.7 to 3.0 million in the 1970s, were consistently below 1 million in the 1980s, and averaged less than 0.4 million in the early 1990s prior to closure of the fisheries in 1994 (Pacific Fishery Management Council (PFMC) 1995 cited in NMFS 1997a). This decline largely reflects reductions in allowable harvest, which were imposed in response to perceived declines in production (Weitkamp et al. 1995).

Timber harvest activities and silvicultural practices dating back to the early 1930's have resulted in extensive degradation of fish habitat in the lower Klamath River watershed and have contributed to the decline of Klamath River salmonids. Road construction associated with these activities and practices created impassable barriers to steelhead and salmon spawning areas in Coon, Crawford, Little Girder, and Beaver Creeks (Taft and Shapovalov 1935 cited in Vogel 1997). Logging caused aggradation in the lower reaches of Blue and Roach Creeks, blocking spawning access during low water (ESA 1980, Payne 1989 cited in Vogel 1997).

Mining in the Klamath River Basin has damaged fish habitat from heavy silt loads. One study of mining impacts was performed in 1934 by the U.S. Bureau of Fisheries (Taft and Shapovalov 1935 cited in Vogel 1997). An analysis of hydraulic mine operations on the East Fork Scott River involved taking samples of benthic macroinvertebrates located on riffles above and below a tributary carry considerable mining silt. Above the silted site, the gravels contained an average of 249 organisms per square foot while below the muddy tributary the average was 36 organisms per square foot (Vogel 1997). These stream fauna represent important food for salmon and steelhead and their loss reduces the capacity of the stream to support fish populations.

In addition to reduction in fish food, silt from placer mining covers salmon redds and suffocates the salmon eggs (Smith 1939 cited in Vogel 1997). The level of egg mortality seems related to the amount of silt. Also, pools filled in with silt leave no hiding or rearing places for fish (Vogel 1997).

Generally, the available water supplies in the Upper Klamath River Basin are insufficient to meet the competing demands for water supplies of the basin in every water year type. Water rights in most of the Upper Klamath Basin are currently unquantified and unadjudicated. The State of Oregon is proceeding with an adjudication of the Klamath River in Oregon. The Upper Klamath Basin Working Group is working with private entities throughout the Upper Klamath Basin to prioritize watershed restoration projects and implement restoration projects on a large and small scale using federal and private funding. It is likely that additional wetland areas will be reclaimed and restored, and degraded riparian areas fenced and restored. Reclamation is seeking additional sources of water and storage capacity to assist in meeting the competing demands for water in the basin.

The timing of flow events is also important because the life cycles of many aquatic and riparian species are timed to either avoid or exploit flow events of different magnitudes. The timing of high or low flow events provides environmental cues for fish to initiate spawning (Montgomery et al. 1983), egg hatching (Naesje et al. 1995), rearing (Seegrist and Gard 1972), and migration (Trepanier et al. 1996).

Although no Klamath River-specific data exists, generally a positive flow-versus-survival relationship has been found in most geographic areas where this relationship has been studied (Cada et al. 1994). This generally means that as river flows increase, fish survival increases. However, there are studies that have demonstrated that a positive relationship does not occur uniformly for all ranges of flows (Vogel 1998).

Studies have shown that high flows maintain ecosystem productivity and diversity. For example, high flows remove

and transport fine sediments which otherwise would fill interstitial spaces in productive gravel habitats (Beschta and Jackson 1979). Other studies support the premise that higher flows would result in higher salmonid smolt survival because these fish would outmigrate faster and reduce exposure time to poor mainstem habitat conditions (Wagner 1974, Lundquist and Ericksson 1985, Glova and McInerney 1977, and Smith 1982 cited in McCormick and Saunders 1987).

High mainstem river spring flows may be necessary to provide rearing habitat for fry and juvenile coho and other salmonids outmigrating from the tributaries. Degraded fish habitat and poor water quality conditions in some tributaries, especially in low water years, may prematurely force the outmigration of salmonids into the mainstem Klamath River.

Until improvements in non-Federal land management practices are actually implemented, Reclamation assumes that future private and State actions will continue at similar intensities as in recent years. Given the degraded conditions for listed and proposed Pacific salmonids, actions that do not lead to improvement in habitat conditions over time could contribute to species decline.

CHAPTER 7.0 - DETERMINATION OF EFFECTS

7.1 INTRODUCTION

The following determination of effects for the Lost River and shortnose suckers, Southern Oregon/Northern California Coast coho salmon Evolutionary Significant Unit (SONCC) and bald eagle consider direct and indirect effects of the proposed action on the listed species together with the effect of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects.

7.2 Lost River and Shortnose Suckers

Based upon the analysis in this BA, Reclamation has determined the following effects of the action on endangered suckers:

? Diversion of water for Project purposes from Klamath River may effect, and is likely to adversely affect, endangered suckers.

? Storing water for Project purposes may effect, but is not likely to adversely affect, endangered suckers and their proposed critical habitat.

? Delivery of water for Project purposes may effect, and would likely adversely affect, endangered suckers.

? Other proposed actions (screening and fish passage) may effect, but are not likely to adversely affect, endangered suckers.

7.3 Coho salmon

- Proposed diversion of water as described in section 5.3.5, although occurring upstream of Iron Gate Dam, may result in diminished flow downstream of Iron Gate Dam and thus may adversely affect the salmon.

- Putting water into storage as proposed may affect, and is likely to adversely affect SONCC coho salmon and likely to adversely modify critical habitat for SONCC coho salmon in “dry” and “critical dry” water year types.

- Water deliveries under the proposed action that involve diversion of impaired flows may affect, and are likely to adversely affect SONCC coho salmon and likely to adversely modify critical habitat for SONCC coho salmon during all water year types except in September of “dry” and “critical dry” water years.

- Proposed water deliveries out of storage at Upper Klamath Lake has no effect on SONCC coho salmon or critical habitat for SONCC coho salmon.

7.4 Bald Eagle

Reclamation’s February 13, 2001 biological assessment stated that the proposed action (i.e. continued operation of the Project to deliver a water supply for irrigated agriculture and refuges) would provide adequate water deliveries to support eagles in most years. Reclamation believes that the effects of the proposed action in this BA would be similar to those described in the 2001 biological assessment. Therefore the proposed action may affect, but is not likely to adversely affect bald eagles.

CHAPTER 7.0 - LITERATURE CITED

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7.2.1 PERSONAL COMMUNICATIONS

Dunsmoor, Larry. Research Biologist. Klamath Tribes, Chiloquin, Oregon.

Hamilton, Andy. Fishery Biologist. Bureau of Land Management, Klamath Falls, Oregon.

Kann, Jacob. Aquatic Ecologist. Aquatic Ecosystem Sciences, Ashland, Oregon.

Simon, David. Research Biologist. Oregon State University. Corvallis, Oregon.

Shively, Rip. Fishery Biologist. Biological Resources Division, US Geological Survey, Klamath Falls Duty Station, Klamath Falls, Oregon.

APPENDIX A - POTENTIAL ACTIONS TO ASSIST WITH PROTECTION, CONSERVATION AND/OR RECOVERY OF LISTED SPECIES

1. INTRODUCTION

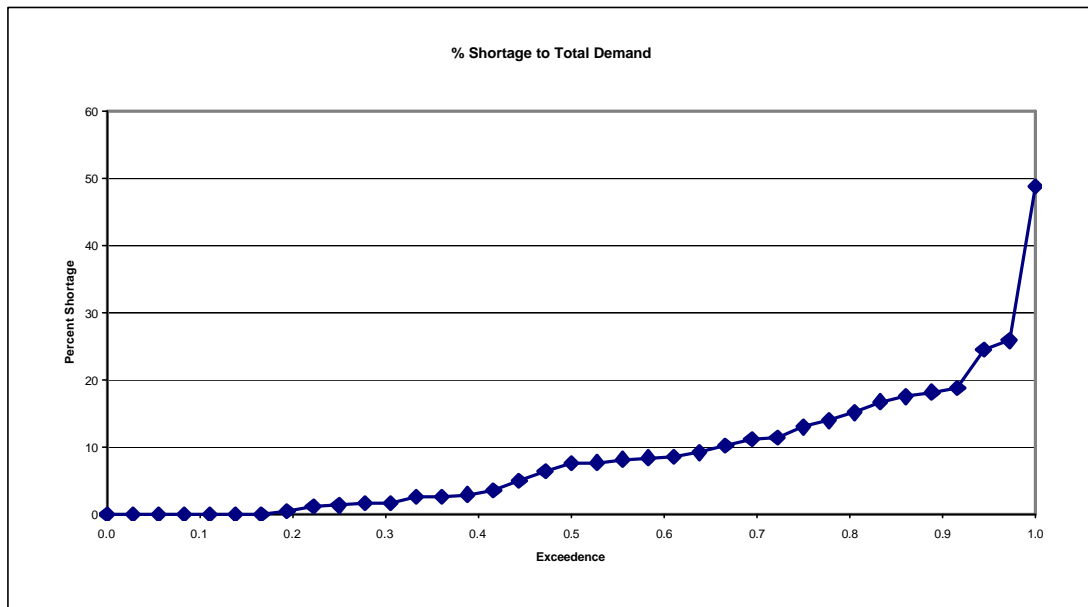
Reclamation has identified a number of potential discretionary actions that could assist with protection, conservation and/or recovery of the listed species. Reclamation would consider participating, along with other partners, in implementing the following actions, subject to authorization and funding. The actions described in this Appendix could be used as elements of a reasonable prudent alternative for Project operation to avoid jeopardy, elements of appropriate recovery plans for the listed species, or voluntary conservation measures/actions to benefit the listed species. Actions identified and selected for implementation would be accomplished within the 10-year period of Project operations described in the biological assessment.

2. PARAMETERS OF A REASONABLE AND PRUDENT ALTERNATIVE CONSISTENT WITH THE ACTION PROPOSED BY RECLAMATION

Any reasonable and prudent alternative (RPA) to avoid jeopardy must be consistent with the intended purpose of the action, implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, and must be economically and technologically feasible. In order to meet these criteria, any RPA designed to avoid the likelihood of jeopardizing the continued existence of listed species considered in this BA must also be consistent with operation of a viable irrigation project. Reclamation has established two general operating criteria for the Klamath Project to define this objective and to guide development of RPAs (if needed), has designed the following program to help meet this criteria through cooperation with water users, and proposes a winter irrigation program to help reduce irrigation demand during the early growing season.

A. Annual Delivery Criteria

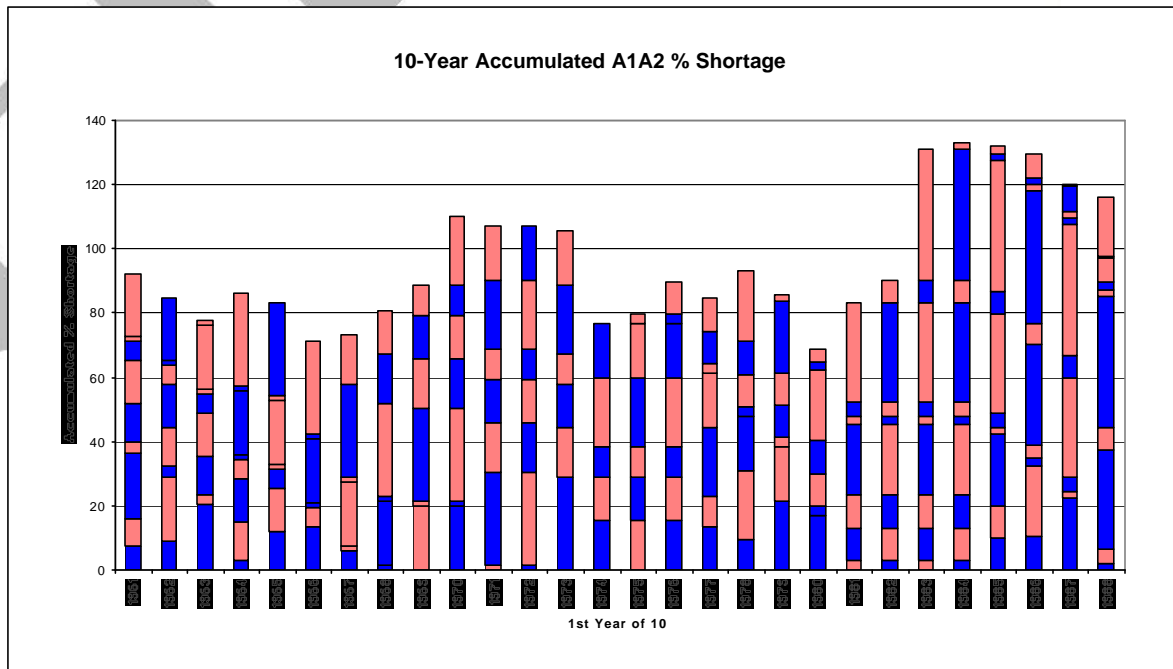
Reclamation used annual water delivery criteria to define the annual water delivery necessary to maintain a viable irrigation project. The criteria requires Project operation deliver at least 50 percent of irrigation demand each year. The following table (source: KPOPSIM run "011102a_distrib_results") illustrates the ability of the proposed action to meet the criteria:



The graph shows that the annual delivery criteria would be met in all years, and the maximum annual shortage would not exceed 49 percent. Annual shortages would be less than ten percent in 24 of 37 years; less than 20 percent in 34 of 37 years; and less than 30 percent in 36 of 37 years.

B. Ten-year Cumulative Delivery Criteria

Reclamation used cumulative water delivery criteria to define the water delivery necessary to maintain a viable irrigation project. The criteria is cumulative shortages in meeting irrigation demand will not exceed 100 percent during any consecutive ten-year period. The following graph (source: KPOPSIM run "011102a_distrib_results") illustrates the ability of the proposed action to meet the criteria ("A1A2" refers to Project lands served by Upper Klamath Lake):



The graph shows that ten-year cumulative criteria would not be met in nine of 28 ten-year periods with the

proposed action. The demand reduction program described in the following section would result in this criteria being met in 27 of 28 periods.

C. Water Use Reduction Programs

Reclamation could reduce water demand through two programs to assist in meeting the annual and 10-year delivery criteria. These programs would be accomplished through cooperation with Project and non-Project water users.

1. Reduce Irrigation Demand for Project Water

Reclamation could implement a voluntary compensated irrigation demand reduction program. The proposed action would likely result in lower elevations in Upper Klamath Lake than those needed to adequately protect endangered suckers. The demand reduction program would use options (or some similar mechanism) based on the April 1 water supply forecast. Reclamation could idle 8,000 acres in a “below average” year, 26,000 acres in a “dry” year, and “36,000” acres in a “critical dry” year. The intent of the demand reduction program would be to both continue to operate a viable irrigation project and not jeopardize the continued existence of listed species. Reclamation considers a project viable if shortages in any single year do not exceed 50 percent of that year’s demand or that cumulative percentage shortages over any 10 consecutive years do not exceed 100 percent. The proposed action meets the first of these tests, but it does not meet the second. Reclamation modeled the historic runoff and demand record for the Klamath Project from 1961 to 1997. During this period, Reclamation found that of the 28 consecutive 10-year periods, the proposed action resulted in shortages in 10 of the 37 years. The maximum cumulative shortage in a consecutive 10-year period was 132 percent. The maximum single year shortage was 49 percent and the average annual shortage was 10 percent. Only seven years showed no irrigation shortage, and 24 of the years had shortages of 10 percent or less. Reclamation operated a pilot compensated demand reduction program in 2001. Reclamation entered into contracts to idle about 16,000 acres at a cost of \$ 2.75 million or \$ 107 per acre. Using the 2001 cost of idling land, the average annual cost for the compensated, voluntary demand reduction is \$1.57 million

2. Water Leasing and Water Banking

Reclamation would develop a program to lease water and work cooperatively with contractors, upstream and downstream water users to make water available for Upper Klamath Lake and the Klamath River downstream. Reclamation also potentially has access to water stored in Upper Klamath Lake by leasing it from existing contractors. Even when Reclamation has water available from the lake, however, it is subject to the limits of the Project’s authorizing legislation, state law and relevant compacts. Leasing available water is contingent on availability of water from willing sellers.

D. Winter Irrigation

Reclamation would implement a winter irrigation program. Winter irrigation would make use of spills (water that cannot be stored and that exceeds needs for downstream flows or other committed uses) to replenish soil moisture. Winter irrigation would result in reduced irrigation demand during the early growing season. This would specifically reduce shortages to irrigation in the early growing season when lake level requirements constrain water deliveries to agriculture. It would also benefit the lake by reducing the amount of water needed during the growing season.

Reclamation proposes to evaluate the potential to use winter irrigation under the authority of the Enhancement Act. Factors that must be considered are the magnitude and timing of spills which would determine the availability of water, the amount and location of lands that could be expected to take advantage of winter water, the amount of water needed to winter irrigate those lands which will vary depending on meteorologic conditions, operational constraints such as the timing of water deliveries (weather must be considered) and changes to the delivery system that might be needed, the costs of providing winter water, and how winter water will affect the demand and operation of the existing water storage system.

It assumed that all winter irrigation would be in the Tule Lake area, that (based on historic pre-irrigation deliveries to leased lands on the Tule Lake refuge) annual winter irrigation would be at the rate of 1.0 acre-foot per acre, that deliveries would only be made to the extent that spills from Gerber and Upper Klamath Lake were available in sufficient quantity, and that the existing irrigation and on-farm systems could be used. Reclamation estimated that about 30,000 acres of Tule Lake area lands would use winter water. This may be a conservative estimate. Reclamation’s analysis showed that 30,000 acre-feet of winter water could be delivered in 31 of the 37 years of record. No water could be delivered in two years, and lesser amounts could be delivered in the other four years.

This winter irrigation would reduce April and May irrigation demand by the same amount as water was delivered in the winter.

3. POTENTIAL ACTIONS TO PROTECT, CONSERVE AND/OR ASSIST RECOVERY OF LISTED SPECIES

These following discretionary measures have been developed and are included in this appendix for consideration by the U.S. Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) as actions that could be undertaken by Reclamation, as needed, to offset adverse effects of Project operations to avoid jeopardizing the listed species, and/or to assist broader recovery and conservation efforts. The measures are in two sections, endangered sucker measures and threatened salmon measures.

A. POTENTIAL ENDANGERED SUCKER ACTIONS

1. Entrainment Reduction

Reclamation would implement specific measures to reduce entrainment of endangered suckers in the Project service area. This action is already included in Chapter 2 of the BA as part of the proposed action. Reclamation would fund a multi-year program to construct and complete entrainment reduction measures in the Project service area. Reclamation would also prepare a monitoring plan to evaluate the effectiveness of entrainment reduction measures. The monitoring plan would be subject to FWS review.

2. Fish Passage

Reclamation would develop and implement specific measures to provide adequate passage of endangered suckers in the Project service area. Reclamation would fund a multi-year program for these measures. Reclamation would also prepare a monitoring plan to evaluate the effectiveness of fish passage measures. The monitoring plan would be subject to FWS review.

3. Upper Klamath Lake Water Quality Refugia Location Study

Reclamation would implement a study to determine the role of water quality refugia areas on adult endangered sucker survival. The importance of these areas on adult sucker survival in the lake is not well understood. The study plan would build on existing radio-telemetry and water quality data and make necessary recommendations for additional studies. The draft plan would be provided to the FWS for review and comment and would likely be a two-year study. Implementation of a two-year study would begin in 2002. An annual progress report would be completed and a final report with management recommendations would be prepared for the FWS review and approval (estimated completion date would be 2004)

4. Upper Klamath Lake (Emergent) Vegetation Study

Reclamation would undertake a study to assess the role of emergent vegetation in larval/juvenile endangered sucker survival. Habitat needs for larval and juvenile suckers in Upper Klamath Lake, including lower Williamson River, are not adequately known. This has a direct bearing on water quality management because emergent vegetation may become unavailable to larvae and juveniles in the lake at lower lake levels. The study would also address emergent wetland restoration needs. Reclamation would provide a study plan to the FWS for review and comment by January 2002. This would likely be a two-year study. An annual progress report would be completed and a final report with management recommendations would be prepared for FWS review and comment (estimated completion date would be 2004).

5. Upper Klamath Lake-Associated Wetlands Study

Reclamation would develop a study plan to assess the performance of three types of lake-associated wetlands, focusing on seasonal nutrient dynamics and decomposition processes and products, and provide recommendations for “in-lake” and “behind-the-dike” reclaimed wetland management that are intended to mimic pre-settlement wetland nutrient uptake and dispersion. The study would also evaluate the role of marsh decomposition products on *Aphanizomenon* growth. Water quality modeling would be conducted, including in-lake wetlands and wetlands that are being developed behind dikes, to determine the significance of these restoration efforts on water quality and fish survival. This would likely be a three-year study. Annual progress reports would be provided to the FWS. A final report including management recommendations and additional study needs would be provided for FWS review and

comment (estimated completion date would be 2005).

6. Link River-Lake Ewauna-Keno Reservoir Habitat Study

Reclamation would develop a study plan to determine the timing of endangered sucker movements in relationship to season and flows, sizes and species composition of suckers in the Link River. The study would address the ability of suckers to pass obstructions in the river below Link River Dam at different flows. Radio-tracking of adult suckers in the Keno Reservoir-Link River reach is proposed as a means to determine when adult suckers migrate, and to provide information on habitat use in this reach. Reclamation would also examine habitat requirements for suckers in Link River, Lake Ewauna, and the Keno Reservoir. The study would focus on what habitats are available to suckers and monitor sucker survival in these areas. The study plan would be provided to the Service and other interested parties for review and comment. This is likely to be a two-year study. Annual progress reports would be provided to the FWS. After the second year, Reclamation would provide the FWS with recommendations for specific actions to restore endangered sucker habitat in Link River, Lake Ewauna and Keno Reservoir (estimated completion date would be 2004).

7. Pilot Oxygenation Study and Project

Reclamation would develop a pilot oxygenation study plan and project. Endangered sucker die-offs in recent years have been associated with low dissolved oxygen conditions in Upper Klamath Lake. Although efforts are underway to improve long-term water quality in the lake through reduced nutrient loading, watershed restoration, and wetland restoration, the benefits from these programs are likely years away from being realized. A short-term program that may improve adult sucker survival in Upper Klamath Lake is introduction of oxygen into a portion of the lake that suckers could use as a refugia during periods of low dissolved oxygen. Construction and operation of the pilot project would occur over a two-year period, if it is determined to be feasible and likely to be successful. An effectiveness-monitoring plan would be prepared for review. An annual progress report would be completed and final report with management recommendations prepared (estimated completion date would be 2004).

8. Upper Klamath Lake Water Quality Program Review and Study

Reclamation would coordinate with the Service to convene a meeting(s) with water quality technical experts to discuss a program for study/monitoring of Upper Klamath Lake water quality/algal growth and nutrient cycling. The meeting would be intended to provide information for Reclamation's use in development of a draft multi-year water quality monitoring/research plan(s) for FWS review. (estimated completion date would be 2003)

9. Upper Klamath Lake Endangered Sucker Spawning Enhancement Pilot Project

Reclamation would, in coordination with the Service, develop a study plan for a pilot project to enhance existing endangered sucker shoreline spawning habitats through addition of spawning substrate and re-establishment of spawning at previously-used spawning areas through use of hatch boxes or some other intervention. Reclamation would implement and monitor the pilot project. Annual monitoring would evaluate spawning use, hatching success and early mortality. Annual reports would be prepared for FWS review. (estimated completion date would be 2005)

10. Agency Lake Ranch Operation and Management

Reclamation would operate and manage Agency Lake Ranch to store water for Project use, improve water quality and increase habitat on the ranch, to the extent feasible. Existing dikes around the property constrain Reclamation's ability to store water.

11. Ecosystem Restoration

Reclamation would support planning and implementation of ecosystem restoration projects in the Klamath Basin related to Project operation. Subject to appropriations, Reclamation would request and provide \$1 million annually to the Ecosystem Restoration Office (ERO) to implement ecosystem restoration projects related to Project operation that contribute to protection of endangered suckers. Up to 15 percent of the total annual funding would be available for ERO overhead expenses necessary to support these ecosystem restoration projects.

12. Coordination and Planning

Reclamation would meet with the FWS, NMFS, Klamath Basin Tribes, PacifiCorp, and irrigation districts on a periodic basis, as needed, to coordinate and discuss water supply conditions, species status and available options for Project operation. The review would include updates on endangered species status, water quality research and monitoring, ecosystem restoration projects, water supply enhancement planning and implementation projects.

Reclamation and the FWS, in coordination with the above entities, would develop an implementation schedule for the actions. The schedule would help develop funding requests and to assure timely accomplishment of the measures and progress towards meeting specific goals to improve water quality, take minimization, and recovery of endangered species. Technical review meetings would be scheduled annually. The purpose of the meetings would be to compile, analyze, and summarize information from the previous year's activities and plan activities for the coming year. Reclamation and the Service would jointly prepare an Endangered Species Act compliance summary report by February 1 annually for submittal to the Regional Director of Reclamation's Mid-Pacific Region and the Service's Manager, California/Nevada Operations Office.

13. Performance Monitoring

a. Reclamation would develop and implement a program to monitor progress in implementing Project operations and these actions (with no less than an annual report). The program would include: (1) baseline monitoring of water quality and habitat conditions in the Project area; (2) description of measures proposed for implementation; (3) the progress actually accomplished in implementing the measures and; (4) the actual results of implemented measures (i.e. as predicted, or more/less than predicted). Reclamation would submit annual progress reports to FWS to assist in determining if the actions are achieving satisfactory progress in accomplishing the goals and objectives prescribed for the listed species. The performance monitoring may result in modification of these actions or Project operations, as appropriate, in response to new information or changed conditions relevant to the Project's effects.

b. In conjunction with L. and M.1. above, Reclamation would coordinate with the FWS in an annual progress review of implementing Project operations and these measures. The purpose of the review would be to assess progress made in removing threats to, or in recovering, the endangered suckers. Significant differences from the predicted results of these measures and Project operations may affect the progress toward achieving specific goals to remove threats, reduce risks, minimize take and assist recovery of endangered species. Such changes in progress could result in re-initiation of consultation. The FWS would make an annual determination of whether sufficient progress has been made in meeting the goals of these measures and Project operations.

B. POTENTIAL THREATENED COHO SALMON ACTIONS

1. Groundwater Development Study

Reclamation would fund a study on the feasibility of developing groundwater resources to replace surface water use or by discharging groundwater directly into Shasta and/or Scott Rivers-may include pilot program.

2. Shasta River Flow Study

Reclamation would fund a study on the availability of water for instream flows and develop an instream flow recommendation for the Shasta River from Dwinell Dam to Parks Creek.

3. Shasta River Wetlands Restoration Program

Reclamation would provide funding and technical assistance for implementation of the Shasta River Wetlands Restoration Program.

4. MOA with California Department of Water Resources

Reclamation would enter into a Memorandum of Agreement with California Department of Water Resources to provide funding to develop the state's ability to assure appropriate use of existing water rights to protect anadromous fish habitat and to provide funding for irrigators to install measurement devices on all existing diversions and encourage the State to enforce over-withdrawal.

5. Fish Passage at Existing Irrigation Dams

Reclamation would provide funding for an inventory and evaluation of fish passage barriers at existing small irrigation dams in the Shasta and Scott Rivers, and work with facility owners to install corrective measures to remove fish passage barriers.

6. Other Fish Passage Barriers

Reclamation would provide funding for an inventory and evaluation of other impediments to fish passage in the Shasta and Scott Rivers, and work with the California Fish and Game Department to seek funding, and work with facility owners, to implement measures to remove fish passage impediments.

7. Coordination of Diversions

Reclamation would work with the California Department of Water Resources to develop a Memorandum of Agreement to encourage coordination among Shasta River and Scott River water users regarding timing of diversions to avoid dewatering reaches of the river used by anadromous fish.

8. Screen Diversions

Reclamation would provide funding and technical assistance, in cooperation with state, federal and tribal agencies, to assist in screening remaining unscreened diversions in Shasta and Scott Rivers.

9. Fish Rescue Efforts

Reclamation would provide staff/equipment and participate in coordinated multi-agency fish rescue efforts in the Shasta and Scott Rivers, and seek a Memorandum of Understanding with those agencies to provide rescue and/or assist fish rescue efforts, when requested.

10. Project-Related Agricultural Return Flow Water Quality Improvement

Reclamation would study methods to treat and/or recycle agricultural return flows from the Klamath Project service area before release into the Klamath River. Reclamation would conduct a feasibility study under P.L.106-498 to develop off-stream storage in the Lower Klamath Lake area to store additional water, improve water quality and provide habitat. Reclamation would conduct a study of treatment marshes to determine the feasibility of using this as a method to improve water quality of the Klamath Straits Drain.

11. Purchase and/or Lease Water Rights (Shasta and Scott Rivers)

Reclamation would work with a non-governmental organization to develop a plan for acquiring water rights in the Shasta and Scott Rivers. Reclamation would seek a funding source to purchase water rights as identified in the plan. Reclamation would research and identify water rights, develop a basis of negotiation and seek out willing sellers over a five-year period (program scope estimated to be about 8,000 acres or 25,000 acre-feet).